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THE

LIVERPOOL GEOLOGICAL SOCIETY

(*Established December 13th, 1859*).

A Retrospect of Fifty Years' Existence and Work.

By W. HEWITT, B.Sc., Assoc.R.S.M.

LIVERPOOL:
C. Tinling and Co., Ltd., Printers, Victoria Street.

1910.

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NOTE.

The following pages dealing with the history of the Liverpool Geological Society for a period of fifty years (from its establishment in December, 1859), and a summary of those dealing with the Geological work done by Members of the Society during the same period, were given as an Address at a meeting of the Society held on December 14th, 1909, as part of the proceedings in commemoration of its Jubilee.

The writer is indebted to several members for kind assistance in collecting the necessary data: to the Vice-President, H. C. Beasley, F.G.S., the Honorary Secretary, W. A. Whitehead, B.Sc., to Mr. A. L. Reade, but most of all to the Honorary Librarian, Miss S. E. Morton.

W. H.

January, 1910

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THE LIVERPOOL GEOLOGICAL SOCIETY

(Established December 13th, 1859).

A RETROSPECT OF FIFTY YEARS' EXISTENCE AND WORK.

The Liverpool Geological Society is in the proud position of being able to look back upon an honourable record of work extending over a period of fifty years. Established in an unostentatious manner in December, 1859, for the purpose of providing opportunities for students of geological science to meet together to assist each other in their studies and investigations, it has pursued an uninterrupted career of quiet, steady and fruitful work down to the present day. It is with the double object of providing a slight memorial of its past history and an incentive to continued life and work that this retrospect has been written. It is divided into three sections:—

A. History of the Society (pages 6 to 25).
B. Its Geological Work (pages 26 to 71).
C. Biographical Notices of some past Members (pages 72 to 99).

To this is added as an appendix a List of the Papers printed in the Proceedings, arranged under the names of the authors.

A.—HISTORY OF THE SOCIETY.

The origin of the Society is to be found in a meeting of nine Liverpool gentlemen which took place at 7, London Road, the residence of Mr. G. H. Morton, on December 13th, 1859. They agreed to the establishment in Liverpool of a Society which should have for its object: "To investigate the structure of the Earth, the character "of its past inhabitants, and the changes now in progress "upon its surface." The names of these gentlemen were H. Duckworth, F.G.S., C. S. Gregson, S. B. Jackson, F. H. Kirby, F. P. Marrat, T. J. Moore, G. H. Morton, F.G.S., G. Thomas, and T. Urquhart. Of these Mr. Duckworth (who is, as far as is known, the only one of the original members living at the date when this is written) was chosen as the first President of the new Society and Mr. Morton as the Hon. Secretary. The first general meeting of the Liverpool Geological Society was held at the house of the Hon. Secretary on Tuesday, January 10th, 1860, when the President read his "Inauguration Address," and a rule was passed "that the "number of Ordinary Members shall not exceed 18."

The modest character of the undertaking is well shown by the following extract from the address given by Mr. Morton as President on the opening of the eleventh session (October, 1869):—"When the first meeting was "held in December, 1859, it was neither intended nor "expected that the Society would become one of the "prominent institutions of Liverpool for the cultivation "of Physical Science. The experience of a few months, "however, was sufficient to prove the desirability of "holding the meetings in a public building instead of at "the residence of one of the members."

The Geological Society of London was established in 1807, and on the celebration of its Centenary in 1907 an address was presented by the Liverpool Geological Society, in which it was stated "As a daughter Society, which "hopes to celebrate its own Jubilee in 1909, we approach "the great Mother Society with sincere gratitude for the "kindly guidance and encouragement which it has at all "times so willingly given."

Prior to the establishment of the Liverpool Geological Society, similar societies had been formed at several centres outside London — the Edinburgh Geological Society in 1834, the Yorkshire Geological and Polytechnic Society at Wakefield in 1837, the Manchester Geological and Mining Society in 1838, and the Glasgow Geological Society (which celebrated its Jubilee last year) in 1858. The association of Hutton and Playfair with Edinburgh, as well as the particularly interesting geological structure of the immediate vicinity, is sufficient to explain the early formation of a special society for the study of geology in that district; while both the Yorkshire and the Manchester Societies were no doubt assisted to a great extent by the close association of those districts with the coal mining industry.

The nature of the country around Liverpool did not offer any direct stimulus to the study of Geology on its practical side, neither did it appear to the ordinary observer to have any particular association with the general problems of greatest interest to the theoretical geologist. It is therefore not surprising to read in Mr. Morton's Presidential Address already referred to (Oct., 1869): "The organisation of a Geological Society in "Liverpool was attended with some difficulty. It was "said that such a Society, 'more especially in a district "'of country which offers so little to be worked out that "'is not already known, and moreover in a town purely

" ' commercial, where, with few exceptions, the people are " ' too much engrossed with other pursuits, and care little " ' or nothing for science in any shape, would be too con- " ' tracted to permit of its existence beyond a very limited " ' period.' " (This statement is said to be taken from a letter to the Hon. Sec. on the occasion of the formation of the Society in 1859.) The criticism in the Presidential address by Mr. H. C. Beasley, F.G.S., at the opening of the fifty-first session of the Society (Oct., 1909), of the continued neglect of the claims of Geology to a recognised place in a modern liberal education—as evidenced by the failure to include a chair of Geology in the organisation of our local University—is a striking confirmation of the truth of the statement adopted by Mr. Morton half-a-century ago, and of the survival of the same general apathy to the present day.

The excellent work which has been done by many members of the Society in the course of the past fifty years—work which is embodied in its published Proceedings and which has in many cases obtained a wide recognition—is a sufficient refutation of the idea that the locality offers no problems of absorbing interest to geological students. One of the best known of these workers (Mr. T. Mellard Reade, C.E., F.G.S.) who has recently been taken from us remarked at the close of one of his papers: " This district is doubtless looked upon with " horror by geologists whose sport is Palæontology; for, " saving a few footprints, there is not a fossil to be found " in the New Red Sandstone. Looking deeper into the " history and geological genesis of things from a physical " point of view, the problems presented for our solution " are to my mind supremely interesting, and calculated to " throw light upon questions of vast importance, and to " aid us in unravelling the tangled skein of history which " our Mother Earth has spun for us." (Proceedings, Vol

V., p. 83. Jan., 1885.) These remarks were made in connection with a paper on the tunnel under the Mersey, just then practically completed, in which paper Mr. Reade brought forward with some natural pride actual evidence, obtained during the excavations for the tunnel, of the buried old valley of the Mersey, of which he had inferred the existence in a paper read before the Society twelve years previously (Jan. 1873). He says "I trust that these "remarks [as to his former conclusions] may not be con-"sidered egotistical, they are in fact necessary to show "practical men that Geology has, in some instances, "attained to the rank of a science. We can *previse*."

And a more recent defence of the district as a field for geological investigation is found in the Presidential Address by Mr. T. H. Cope, F.G.S., in October, 1904, on "Some Geological Problems in South-west Lancashire" (Proceedings, Vol. X., p. 1), where there is set out an admirable resumé of questions still awaiting solution at the hands of local geologists, in connection with the sand-dunes, coast erosion, changes of level, ancient meres and river channels, glacial striæ, the petrology of the local rocks and of the erratics, &c.

As regards the *local area* which was recognised by the Society as its special field of study, Mr. Morton in his address in 1869 says "In the absence of any satisfactory "geographical boundary we are almost compelled to adopt "a geological area and to consider the Mountain Lime-"stone of Flintshire as our foundation rock. That "formation occurs within 15 miles of the Liverpool Ex-"change, and by including it in our local area we have the "whole of the Carboniferous group." These include the Yoredale Series and Millstone Grit (Cefn-y-Fedw Sandstone) of North Wales, Knowsley, Parbold, &c., and the Coal Measures of North Flintshire, Neston, Prescot, St.

Helens and Wigan. In addition there are the Permian beds at Bispham, St. Helens Junction, &c., the Trias extending over a large part of the area, the glacial beds covering most of the lower levels, and the Post-glacial deposits adjacent to the shores of the estuaries and to the sea-coasts of Lancashire and Cheshire.

The geological work carried out by members of the Society has, however, extended over a much wider field; though it will in most cases be found that these wider excursions have been undertaken with a view to obtaining further light upon some of the problems arising out of a study of the local strata.

Before the establishment of the Liverpool Geological Society several papers on the Geology of the district had been communicated to older scientific societies in the town; for the most part to the Literary and Philosophical Society (established 1812), but some were brought before the Liverpool Natural History Society which appears to have ceased to exist as a separate Society in 1844. From the list of early papers on the local Geology given by Mr. Morton in the Proceedings for Session 1869-70, it would appear that the matters which first enlisted the attention of local observers were connected with the estuary of the Mersey and the peat and forest beds on the neighbouring shores. Thus we find a paper read before the Literary and Philosophical Society in the session 1827-8 by Mr. J. Jevons on "Reasons for the late extraordinary changes in the Bed of the River Mersey, with suggestions for its improvement." In May, 1846, the Rev. Dr. Hume communicates "Notes of an Oral Lecture delivered on Geological subjects during a recent Excursion to Storeton," and another on "The Antiquities found at Hoylake," in which a section at Poulton Bridge was described; in 1856 Mr. Morton read a paper on "The Sub-divisions of the New

Red Sandstone between the River Dee and the 'up-throw' of the Coal Measures east of Liverpool." In the Transactions of the Historic Society of Lancashire and Cheshire for 1857-8, is a paper by Mr. T. J. Moore, being a "Notice of Mammalian Remains discovered in the excavation at Wallasey for the Birkenhead New Docks." These and other communications show that there was in existence a body of local observers for whom a special Geological Society would serve as a rallying ground and a means of focussing, discussing and recording their observations.

The British Association had held its 1854 meeting in Liverpool, at which meeting Mr. Edward Hull, F.G.S., who had recently completed his survey of the district, read a "Paper explanatory of a Geological Section, extending from the Island of Little Eye across the Peninsula between the estuaries of the Dee and Mersey to the east of Liverpool," an abstract of the paper being printed in the Report of the Association. The stimulus which this gave to local workers is shown by the fact that at the first meeting of the Society, January, 1860, Mr. Morton communicated a paper in which he pointed out that the map published by the Geological Survey on the basis of Mr. Hull's work required correction as regards the base of the Keuper formation, in view of sections exposed in the railway tunnel and other openings.

A few weeks before the establishment of the Liverpool Geological Society Sir Charles Lyell had delivered his Presidential address to the Geological section of the British Association meeting at Aberdeen "On the occurrence of works of Human Art in Post Pliocene Deposits," in the course of which he expressed an opinion in favour of the genuine character and antiquity of the flint implements found at Amiens and Abbeville. The subject had been prominently brought forward earlier in the year by Mr. (afterwards Sir) Joseph Prestwich in a communication to the Royal Society (May 26, 1859) "On the occurrence of Flint Implements associated with the remains of animals of Extinct Species. . . ." This, together with the announcement of a similar association of flint implements with the relics of extinct mammalia in the Brixham Cave, which Prestwich communicated to the Geological Society of London in June, 1859, had evidently excited much interest in our district, for we read in the account of the first meeting of the Society (Jan., 1860) that the President in his address "dwelt at considerable length "on the important researches of Mr. Prestwich in the "valley of the Somme in France, and of Dr. Falconer in "the Maccagnone caves in Sicily, in connection with that "most interesting question of the day 'Man among the "'Mammoths'" (Abstract of Proceedings 1859-60). The subject was brought forward again by the same President (Mr. H. Duckworth, F.G.S.) at the meeting in March, 1862, as the result of a personal visit to Amiens and Abbeville.

Only two or three weeks before the meeting at which the Society was constituted, Darwin had published his "Origin of Species." In his Presidential address during the second session of the Society (Feb. 1861) we read that Mr. Duckworth "reviewed the geological arguments in "Mr. Darwin's work on the 'Origin of Species' and "Professor Phillips' 'Origin and Succession of Life upon "'the Earth' and earnestly recommended the members of "the Society to study both sides of the question fully "before forming any decided opinions upon the subject."

These references will serve to give some idea of the circumstances under which the Society started upon its work.

PLACE OF MEETING.

The two general meetings of the Society during the first session (1859-60) were held at Mr. Morton's house, as was also the first general meeting of the second session October, 1860). The building for a Free Public Library and Museum, given to the town by Mr. (afterwards Sir) William Brown, was opened on October 18, 1860, and the Geological Society (in common with some other scientific societies of the town) was granted the use of a room in the new building in which to hold its meetings. The general meeting held in December, 1860, was therefore held in the new Museum, and there the Society continued to meet until March, 1864. The first meeting of the sixth session (October, 1864) was held in the Royal Institution, Colquitt Street, in which institution all the subsequent meetings have been held. The reason for changing the place of meeting to the Royal Institution is stated in the minutes of the Council to be that the rooms were more convenient and the Geological Collection (then in existence at the Royal Institution but since transferred for the most part to the Bootle Museum) would be available for reference. In the first session it was decided to apply to the Directors of the Royal Institution for the members of the Society to have free admission to this collection, which was readily granted.

PRINTED PROCEEDINGS.

There was no intention when the Society was established of publishing a separate record of its proceedings, the only record preserved being a statement in the minute book of the formal business together with a short abstract by the Secretary of the substance of the papers read. From the minutes of the first general meeting in January, 1860, it appears that "The President recom-"mended the members individually to subscribe for the "'Geologist Magazine,' as the proceedings of the "Society were expected to appear in that publication;"

and in the following year a note follows the minutes of the opening meeting for the session to the effect that "An "excellent report of the meeting appeared in the Geo-"logist Magazine of the present month."

It was, however, soon found that it would be desirable to print and circulate an abstract at least of those communications read before the Society which contained records of observations, and at the end of the second session (March, 1861) the Council decided "That the rules, list of mem-"bers, and an abstract of the proceedings of the Society "for the past two sessions, be printed, providing the "Society has funds for the purpose." Such an abstract (being for the most part a copy of the Secretary's entries in the minute book) was accordingly printed as a pamphlet of 14 pages covering the work of the first and second sessions. For each subsequent session a separate record has been printed, which up to and including Session 15 bore the title "Abstract of the Proceedings "of the Liverpool Geological Society." From Session 16 (1874-5) onwards the annual publications are designated "Proceedings," and are divided into volumes (each containing from 4 to 6 annual parts) commencing with Volume III.; the Abstracts for the years 1859-74 being regarded as forming Volumes I. and II. The Proceedings for the fiftieth session will complete Volume X. It is safe to say that the best memorial of the Society's work, during the first fifty years of its existence, is to be found in these volumes, which contain the record of the results of a large amount of painstaking original labour and thought, and a store of information on local geological and geographical facts which in many cases could not now be otherwise obtained.

On the occasion of the general meeting on December 9, 1879, when the Society was entering upon its twenty-first year, the Hon. Secretary (Mr. G. H. Morton, F.G.S.)

read from the minute book his own minute of the preliminary meeting which was convened to form the Liverpool Geological Society, on the 13th of December, 1859; and at the following general meeting (Jan. 13, 1880) he read the minutes of the first general meeting of the Society (Jan. 10, 1860), and "stated that 210 papers and "addresses had been read before the Society and that "153 of them had been printed either in abstract or "*in extenso* in the Proceedings of the Society." From the 21st Session to the 50th Session inclusive, 291 papers have been read and 232 printed in the Proceedings in full or in abstract, making a total for the fifty sessions of 501 papers read and 383 printed.

DISCUSSIONS AND EXHIBITS.

The usefulness of the Society is not, however, to be measured merely by the published papers. The discussions following the reading of the papers—as well in the case of those papers which for various reasons were not subsequently printed as in those which were afterwards incorporated in the Proceedings—were of great value in many ways. Another source of great interest and usefulness is to be found in the exhibit and oral description of specimens of rocks, minerals or fossils, which members have collected or otherwise obtained, or of interesting books, maps, sections, &c. The first of such exhibits recorded in the minutes was at the second meeting of the Society (March 13, 1860) when Mr. Morton exhibited "a "number of scratched boulders and shells collected by "him from the Boulder Clay." There have probably been very few meetings since that date when one or more interesting exhibits have not been forthcoming; sometimes of local interest and obtained from the immediate vicinity, sometimes obtained from very distant localities such as the exhibit at a recent meeting of a specimen of the rock fragments which form the remarkable stone rivers of the Falkland Islands, which were described by Charles Darwin.

FIELD MEETINGS.

In addition to the regular indoor meetings held monthly during the winter for the reading and discussion of papers, the Society has from the first held Field Meetings at various places of geological interest in the vicinity or at some distance, arranging for one of the members or some other person having knowledge of the locality to act as leader. There is no record of a Field Meeting in the first short session, but at the end of the second session excursions were made to Holywell (July 11, 1861) to examine the Mountain Limestone, and to Coalbrookdale (July 31 and August 1, 1861) to examine the Silurian Strata. An account of both these excursions appears in the published Proceedings of the third session. The next Field Meeting was held at Storeton on Monday, July 7, 1862, when Mr. Morton exhibited his section of the Storeton Beds, which was afterwards published as a lithograph on a smaller scale in the first edition of his "Geology of the Country around Liverpool," and was reprinted with the report of the excursion in the Society's Proceedings. In September of the same year a Field Meeting was held at Leasowe to examine the Sub-marine Forest beds. That the excursions were not confined to summer weather is shown by a record of one of the early Field Meetings in the minute book as follows: "The "ground was covered with snow, but as the stratification "and faults were exposed the time was pleasantly spent, "and the proceedings terminated with tea at the ——— "Hotel."

Some of the excursions were arranged jointly with other scientific societies. The first of such joint meetings recorded in the minutes was one to Llangollen in July, 1864, when it was arranged to meet the Manchester Geological Society and the Dudley and Midland Geological Society and Field Club. In 1871 a friendly arrangement was come to with the Liverpool Naturalists' Field Club (which was established a few months after the Geological Society) by which the members of the Geological Society could take part in the field meetings arranged by the Club, and on various occasions joint field meetings have been arranged, especially in the earlier years of the Society. Within the last three or four sessions joint meetings have been held with the North Staffordshire Field Club, the Liverpool Biological Society, the Teachers' Nature Study Club, and others.

Since the year 1888, in addition to numerous short day excursions, an excursion covering from three to five days has usually been arranged at Easter or Whitsuntide, and the Society has been favoured on these long excursions, as a general rule, by very considerable practical assistance from eminent geologists resident in or acquainted with the localities visited. In this way the Society has visited the following districts:—The South of the Isle of Man (1888), North coast of Anglesey (1889), Leicester (1890), Settle (1891), Mold (1892), Belfast (1893), Church Stretton (1894 and 1900), Appleby (1895 and 1901), Malvern (1896), Ffestiniog (1897), Keswick (1898), Cheltenham (1899), Much Wenlock (1902), Uttoxeter (1906), Colne (1907), and the Berwyns (1908).

LIBRARY.

The Society has gradually formed a very useful library of geological literature, partly by purchase, partly by gifts of books and papers by individuals, but largely by the receipt of the publications of other societies in exchange for the printed Proceedings. For some sessions the Hon. Secretary acted also as Librarian, but in 1875 it was decided to appoint a special Hon. Librarian, and in 1875 Mr. Edwin Foster, a member of the Society, was so appointed, and continued to act until Session 30 (1888-9), followed later by Mr. J. J. Fitzpatrick (Sessions 31 to 37), Mr. W. Mawby (Sessions 38 to 41), Mr. W. A. Whitehead (Session 42), and Miss S. E. Morton (Sessions 43 to 50).

Geological Photographs.

At the meeting on Jan. 12th, 1886, the minute book records that Mr. H. C. Beasley suggested that "an effort "should be made to secure photographs of interesting "sections and phenomena which are likely to be soon "hidden from view, and that the Society should make a "collection of such photographs for reference." Later in the same year the Council decided to purchase copies of twelve photographs taken at recent field meetings of the Society. Two years later another member of the Society (Mr. Osmund W. Jeffs), at the meeting of the British Association (Bath, 1888), suggested the appointment of a Committee to collect and register photographs of geological interest, and in the following year (1889), at the Newcastle meeting of the Association, such a Committee was appointed, with Mr. Jeffs as Secretary, for the collection, preservation and systematic registration of photographs of geological interest in the United Kingdom. The work of that Committee—which is still going on—has resulted in bringing together a large and important collection of photographs and rendering them available for educational purposes.

Local Geological Collections.

The Society has on several occasions taken action in connection with the exhibits of geological collections in the public museums of the district. As already mentioned, the Society in the beginning of its career sought and obtained permission for its members to visit the collections then displayed in the Royal Institution. In connection with the establishment of a Free Public Museum in Liverpool in 1860, the question of the arrangement of the geological collection was discussed at the second and following meetings of the Society, on the proposal by the Rev. H. H. Higgins (a member of the Society, and a co-opted member of the Museum Committee) to "arrange the fossils, without regard to "formation, with the recent species in the zoological "collection." Most of the members of the Society advocated a geological arrangement of the fossils, and after several discussions of the subject the Society at the first meeting of the second session (October 23rd, 1860) passed a resolution—"That the Geological Society would "view with regret any arrangement of the Organic "Remains in the new Free Public Library and Museum "which would not afford the student of geology the "means of prosecuting his researches. The Society "therefore advocates a geological arrangement of the "Fossils in groups according to their relative age and "position in the stratigraphical series of rock formations." At the second general meeting of the Society, Mr. Thomas Urquhart, one of the original members, announced that Mr. Wm. Pengelly was willing to present to the Liverpool Free Public Museum (through Mr. Urquhart) a collection of Devonian Fossils; and at a subsequent meeting (December 11th, 1860) we read in the minutes that Mr. Urquhart "presented to the Liverpool Museum, through "the medium of the Society, a beautiful series of "Devonian Fossils, under the name of the 'Pengelly "'Collection,' many of the specimens having been cut "and polished in order to show their internal structure."

In March, 1891, after a visit to the Bootle Museum, the Council of the Society resolved "that the Secretary "be directed to respectfully draw the attention of the "authorities of the Bootle Museum to the present position "of their valuable and important examples of Triassic "footprints, and to the desirability of their being placed, "if possible, in a position where they will be more readily "seen than at present."

Again in 1901, on the extension of the Liverpool Museum, the question of the provision and display of adequate geological collections was discussed at the general meetings in January and February of that year, and a communication was addressed by the Council of the Society to the Library, Museums and Arts Committee of the City Council urging, *inter alia*, that adequate space should be provided for a comprehensive Local Collection illustrating the geology of the district, and that in the arrangement of the Local Collection especial attention should be given to the adequate illustration of the stratigraphic and economic features of the district.

Geological Society's Awards to Members.

The value of the geological work done by several members of the Society has been recognised by the parent society—the Geological Society of London—by the award to them of medals and funds to assist them in their researches. Thus the balance of the Lyell Fund was awarded in 1886 to Mr. D. Mackintosh, F.G.S.; the Lyell Medal to Mr. G. H. Morton, F.G.S., in 1892; the Murchison Medal to Mr. T. Mellard Reade, F.G.S., in 1896; the proceeds of the Barlow-Jameson Fund to Mr. H. C. Beasley, F.G.S., in 1906, and the balance of the proceeds of the Lyell Fund to Mr. J. Lomas, F.G.S., in 1907.

PRESIDENTS.

During the fifty years under consideration the office of President of the Society has been filled by 19 members. Of these, Mr. H. C. Beasley, F.G.S., and Mr. T. Mellard Reade, F.G.S., have each been elected President on three occasions; Mr. H. Duckworth, F.G.S., Mr. J. Lomas, F.G.S., Mr. G. H. Morton, F.G.S., and Dr. C. Ricketts, F.G.S., each on two occasions. The list of Presidents in order of succession is as follows:—

Sessions	1—3	Henry Duckworth, F.G.S.
,,	4—5	Professor H. Griffiths.
,,	6—7	Henry Duckworth, F.G.S.
,,	8—9	Robert A. Eskrigge, F.G.S.
,,	10—11	George H. Morton, F.G.S.
,,	12—13	Dr. Charles Ricketts, F.G.S.
,,	14—15	Isaac Roberts, F.G.S.
,,	16—17	T. Mellard Reade, F.G.S., C.E.
,,	18—19	Hugh F. Hall, F.G S.
,,	20—21	William Semmons.
,,	22	Professor J. Campbell Brown, D.Sc., F.C.S.
,,	23—24	Daniel Mackintosh, F.G.S.
,,	25—26	T. Mellard Reade, F.G.S., C.E.
,,	27—28	George H. Morton, F.G.S.
,,	29—30	Henry C. Beasley.
,,	31	Dr. Charles Ricketts, F.G.S.
,,	32—33	William Hewitt, B.Sc., Assoc. R.S,M.
,,	34—35	Edmund Dickson, F.G.S.
,,	36—37	T. Mellard Reade, F.G.S., C.E,
,,	38—39	Joseph Lomas, F.G.S., A.R.C.S.
,,	40—41	Professor W. A. Herdman, D.Sc., F.R.S.
,,	42—43	Charles C. Moore, F.I.C.
,,	44—45	Thomas H. Cope, F.G.S.
,,	46—47	Henry C. Beasley, F.G.S.
,,	48—49	Arthur R. Dwerryhouse, D.Sc., F.G.S.
,,	50	Joseph Lomas, F G.S. (to December). Henry C. Beasley, F.G.S. (elected January, 1909).

HONORARY SECRETARIES.

There have been only five Hon. Secretaries of the Society in the course of fifty years, and one of these acted only temporarily for two sessions (1868-70) during Mr. Morton's first term of office as President. The list is as follows:—

Sessions	1—9	George H. Morton. F.G.S.
,,	10—11	Hugh F. Hall, F.G.S.
,,	12—26	George H. Morton, F.G.S.
,,	27—31	William Hewitt, B.Sc.
,,	32—42	Henry C. Beasley, F.G.S.
,,	43—50	William A. Whitehead, B.Sc.

HONORARY TREASURERS.

The finances of the Society have been administered by the following Hon. Treasurers:—

Sessions	1—4	The Hon. Secretary acted also as Treasurer.
,,	5	William S. Horton, F.G.S.
,,	6—8	Samuel B. Jackson.
,,	9—13	Frank Archer, B.A.
,,	14—21	Alfred Morgan.
,,	22	Henry Young.
,,	23—34	Edward M. Hance, LL.B.
,,	35—37	Thomas Goffey.
,,	38—41	William Hewitt, B.Sc.
,,	42—50	William H. Rock.

MEMBERS.

The roll of membership shows a total of 283 individuals as ordinary members of the Society during the period of 50 years. In the first session there were 14 members; the fiftieth session has a roll of 11 Honorary Members, 2 Foreign Corresponding Members, 45 Ordinary Members, and 6 Associates. The following is a list of the names of members of the Society whose membership extended over at least 20 sessions. [The numbers after the names give the number of sessions for which the name appears in the list of members, and the figures in brackets show for which sessions.]

Abraham, J.	20	[2-21]
Archer, F., B.A.	25	[8-32]
Beasley, H. C., F.G.S.	39	[12-50]
Bostock, R.	24	[4-27]
Brown, J. Campbell, D.Sc.	35	[16-50]
Cumming, L., M.A.	20	[31-50]
Davies, C.	26	[3-28]
Davies, D.	22	[29-50]
Dickson, E., F.G.S.,	24	[27-50]
Eskrigge, R. A., F.G.S.	31	[4-34]
Fitzpatrick, J. J.	28	[17-44]
Fitzpatrick, M.	34	[14-47]
Foster, E.	22	[13-34]
Goffey, T.	22	[27-48]
Gregson, S. Leigh	22	[3-24]
Hall, H. F., F.G.S.	22	[5-26]
Hance, E. M., LL.B.	23	[16-38]
Herdman, W. A., D.Sc., F.R.S.	27	[24-50]
Hewitt, W., B.Sc.	32	[19-50]
Higgins, H. H., B.A. (Rev.)	33	[2-34]
Hill, H. Ashton, C.E.	20	[31-50]
Holland, P., F.I.C.	23	[28-50]
Jones, T.	20	[6-25]
Keyte, T. S., C.E.	24	[27-50]
Lomas, J., F.G.S.	23	[27-49]
Marrat, F. P.	33	[1-33]
Mayer, J.	22	[3-24]
Moore, C. C., F.I.C.	24	[27-50]
Moore, T. J.	33	[1-33]
Mortimer, Capt.	31	[4-34]
Morton, G. H., F.G.S.	41	[1-41]
Picton, J. A. (Sir) F.S.A.,	29	[2-30]
Potter, C.	34	[6-39]
Reade, T. Mellard, F.G.S.	38	[12-49]
Richardson, W. A., C.E.	32	[9-13, 17-43]
Ricketts, C., M.D., F.G.S.,	37	[5-41]
Roberts, I., F.R.S., F.G.S.	28	[4-31]
Robinson, J. J.	32	[19-50]
Shone, W.	37	[14-50]
Timmins, A., C.E.	29	[22-50]
Ward, T.	31	[14-44]
Wright, B. M.	23	[5-27]

Throughout the whole course of its existence the Society has had the advantage of having associated with it, as **Honorary Members,** men of eminence in geological science, some of whom have from time to time favoured the Society with interesting communications either in the form of papers or lectures. The present roll of Honorary Members comprises Professor T. G. Bonney, D.Sc., LL.D., F.R.S., F.G.S. (whose address on "Fragmental Rocks as Records of the Past" is contained in the Proceedings for Session 1901-2); Chas. Callaway, D.Sc., F.G.S. (paper on "The Archæan Geology of Anglesey," in Proceedings for Session 1900-1901); Professor W. M. Davis, of Harvard University (address on "The Colorado Canyon and its Lessons," in Proceedings for Session 1905-6); Sir Archibald Geikie, LL.D., D.Sc., F.R.S., F.G.S.; Professor J. W. Judd, C.B., F.R.S., F.G.S.; Professor Chas. Lapworth, LL.D., F.R.S., F.G.S.; Professor W. W. Watts, M.A., F.R.S., F.G.S. (address on "The Buried Landscape of Charnwood Forest," in Proceedings for Session 1903-4); W. Whitaker, B.A., F.R.S., F.G.S. (contributed "List of Works on the Geology, Mineralogy, and Palæontology of Cheshire" to Proceedings for Session 1875-6); Henry Woodward, LL.D., F.R.S., F.G.S.; and Joseph Wright, F.G.S.

The records of previous sessions show that the roll of past Honorary Members comprises the names of Professor John Phillips, F.R.S., F.G.S.; Sir Andrew C. Ramsay, F.R.S., F.G.S.; J. Beete Jukes, F.R.S., F.G.S.; John Morris, F.G.S.; S. J. Mackie, F.G.S.; Sir William Brown; W. Pengelly, F.G.S.; E. W. Binney, F.R.S., F.G.S.; W. Bryham; Dr. Henry Hicks, F.R.S., F.G.S.; Dr. W. King; Daniel Mackintosh, F.G.S.; Dr. Chas. Ricketts, F.G.S.

In 1888 several eminent geologists in other countries consented to become Foreign Corresponding Members of the Society, viz.:—M. A. Daubrée, Paris; Dr. A. Heim, Zurich; Major-General N. von Kokscharrow, St. Petersburg; Professor J. Vilanova-y-Piera, Madrid; Dr. A. F. Renard, Brussels; Baron F. von Richthofen, Berlin; Professor J. J. Stevenson, New York; and Mr. R. T. Litton, of Melbourne.

B.—GEOLOGICAL WORK.

While the range of subjects which have come under consideration at the meetings of the Society in the course of the past fifty years is naturally very wide, there are certain subjects—mainly connected with the geology of the local area—which have received special attention and excited special interest. The most important of these may be summarised as follows:—

(1) The local Triassic rocks—their structural characters, divisions and distribution; the conditions under which these rocks were originally formed; the direction and character of the faults by which they have been affected.

(2) The Storeton footprints.

(3) The Glacial beds—their characters and distribution; the contained boulders, shells and foraminifera; the occurrence and character of glacial striæ; together with the conditions under which the deposits and striæ were formed.

(4) The Post-Glacial beds of the district.

(5) The submerged forests on the shores of Lancashire and Cheshire.

(6) The estuary of the Mersey and the former course of the river.

(7) Changes in the topography of the district.

(8) The local water supply.

In the course of the discussions on some of these subjects there has not unnaturally been from time to time sharp divisions of opinion, and controversies have arisen which have, as a general rule, had the effect of intensifying the interest in the science and stimulating to further investigation.

A very brief sketch of the work of the Society, arranged under the above heads, as shown by the papers published in the Proceedings, will perhaps be the most convenient form in which the history of the Society as a working body may be indicated. Such an outline, however, under the circumstances in which this historical sketch has been prepared, must necessarily be only cursory and incomplete; and those who are interested in any particular subject or subjects will as a matter of course go direct to the original records. Much of the material of the earlier papers, from the commencement to about the thirty-first session (1890), is incorporated with or referred to in the second edition of Mr. Morton's book on "The Geology of the Country around Liverpool."

I.—LOCAL TRIASSIC STRATA.

Various beds of Triassic age form the solid geology of that part of South-west Lancashire in the immediate neighbourhood of Liverpool, as well as of the Wirral Peninsula and the adjacent parts of Cheshire. Although covered in many parts by a mantle of boulder clay, the harder beds occupy bare elevated positions in various parts of the district, while the fact that some of the sandstones form excellent building stones has led to the opening of a number of quarries. The characters of the various beds, and the conditions under which they were probably formed, have been subjects of constant observation and discussion by members of the Society. A short time before the establishment of the Society the district had been surveyed for the Government Geological Survey by Professor Edward Hull, F.G.S., and the map of the district issued, the strata being classified in descending order as Keuper Marls, Keuper Sandstone, Upper (Soft) Bunter Sandstone, Pebble beds of the Bunter, and Lower (Soft) Bunter Sandstone.

The lowest bed of the Keuper is a well-marked feature, and formed the subject of a paper read by Mr. G. H. Morton, F.G.S., at the first meeting of the Society (January 10th, 1860) on "The Basement Bed of the Keuper Formation in Wirral and South-west Lancashire," where it is described as being very uniform in its lithological character, "a conglomerate of coarse sandstone, "containing quartz pebbles and nodules of clay." At the end of the fifth session Mr. Morton conducted a field meeting to Bidston Hill to examine a good exposure of this bed, where he pointed out "a very strong appearance "of unconformity" between it and the underlying Bunter Sandstone. On November 11th, 1890, Mr. H. C. Beasley, F.G.S., read a paper on "The Base of the Keuper in the Northern part of Wirral," in which he described the basement bed as seen in a number of different localities, from which he drew the conclusion that while the transition from the Bunter to the Keuper was less abrupt in some places than in others, there had been some erosion (not necessarily sub-aerial) of the upper beds of the Bunter before the lower beds of the Keuper were laid down over them. He referred to the exposure in a section at Wallasey of a coarse bed containing "large fragments of "a broken up bed of shale, very irregularly disposed," which had been pointed out by him on the occasion of a field meeting of the Society.

The Keuper Sandstone extensively quarried for building purposes at Storeton is there let down by a trough fault between the softer beds of the Bunter to the East and West, as was shown by Mr. Morton on the section exhibited and described to the Society at the field meeting in July, 1862, and of which a lithograph accompanies the report in the Abstract of the Proceedings for the fourth session (1862-3). Twenty years later (November, 1882) Mr. Morton exhibited and described a "Geological Map of the Storeton Quarries, Cheshire," being a section of the 25-inch Ordnance Map, on which he had marked the strata and 22 faults which he had traced in an area of about half a mile. The thickness of the Keuper at Storeton he gives as 208 feet.

An excellent opportunity for studying the relation of the Triassic beds under Liverpool was afforded by the section exposed over a length of 2,300 yards when the railway tunnel from Lime Street to Edge Hill on the London and North-Western Railway was opened out. These sections were examined at a field meeting by the Society, and were carefully followed during the course of the work by Mr. Morton, who described them before the Society, with a section drawn to scale, on November 13th, 1883. He showed that here also the Keuper occurs as a wedge-shaped mass of sandstone running North and South through the centre of Liverpool, with the beds of the Bunter on both East and West sides. He notes that while faults are numerous in the dropped Keuper, the beds of the Bunter are very little faulted.

The interesting footprint beds of the Keuper Sandstone are referred to under another heading.

The upper beds of the Keuper—the Keuper Marl—are not exposed at the surface to the same extent as the harder beds of the series, and have not offered so large an opportunity for special examination. Mr. Beasley described sections of these beds exposed at Oxton on December, 1885 ("On a Section of the Upper Keuper at Oxton"), and again in December, 1900 ("Some Recent

Exposures of Keuper Marls at Oxton"). From these beds Mr. J. Lomas, F.G.S., obtained specimens of Estheria and plant remains (along with salt pseudomorphs), which he described in a paper read on December 11th, 1900; and Mr. Beasley, in his Presidential Address in October, 1889, on the "Life of the English Trias," describes some obscure plant remains which he obtained from the section of the marls at Woodchurch. In a subsequent Presidential Address (October, 1905) on "Some Difficulties with Regard to the Formation of the Upper Keuper Marls," Mr. Beasley deals briefly with the variation of these beds in the district and in other localities.

The Lower Trias or Bunter is referred to and described incidentally in many papers, *e.g.* in Mr. Morton's paper above mentioned on the opening out of the tunnel between Lime Street and Edge Hill. The nature and origin of the quartz and quartzite pebbles which are so abundant in certain beds—the hard beds forming the middle section of the Bunter being described as the Pebble Beds, though often free from pebbles—have been frequently discussed. In a paper on "The Trias of Cannock Chase," read by Mr. T. Mellard Reade, C.E., F.G.S., March 8th, 1892, he pointed to the great difference between the pebble beds in the Liverpool district, which, "as a rule, are simply sandstones with a few quartzite, "quartz, and other pebbles scattered through them," and the corresponding beds in the Cannock Chase district of Staffordshire, which are composed almost wholly of pebbles and boulders, closely packed together, the interspaces being filled with crumbly sandstone or loose sand. The "Trias of the Vale of Clwyd" was described by Mr. Reade on January 14th, 1891, the beds consisting of a bright red sandstone, probably representing the Lower Bunter and resting directly on the Carboniferous rocks.

The question of the exact age of the soft sandstones underlying the Bunter pebble beds has been a subject of some discussion, and the possibility of it representing, in some cases at least, the Permian formation, has been considered. The beds are described and the question of age raised in a paper by Mr. Morton (February 14th, 1882) on "The Base of the New Red Sandstone in the Country around Liverpool." The same question is discussed in a paper read by Mr. A. Timmins, C.E. (January 8th, 1889), "Notes on a few Borings and the Base of the New Red Sandstone in the Neighbourhood of Liverpool," and by Mr. Beasley in his Presidential Address at the opening of the same session (October, 1888).

[A description of the section of undoubted Permian strata at Skillaw Clough, near Parbold, was given by Mr. E. Dickson, F.G.S., in a paper read before the Society in April, 1893; and in another paper (March, 1895), "Further Notes on the Section at Skillaw Clough," in which he announced the discovery of a fossil shell (Schizodus) in the bed of magnesian limestone and numerous Permian fossils in the shales and marls underlying the limestone in the section.]

On April 7th, 1903, Mr. W. Edwards, F.G.S., read a paper on "The Surface Geology of Cheshire in its Relation to Agriculture," in which he pointed out several facts of interest in connection with the Triassic rocks of that county, *e.g.* (1) nearly all the villages in the Bunter area are situated on the higher portions of the pebble beds, which are left uncovered by the glacial drift; (2) while in other areas the Bunter sandstones and conglomerates yield some of the poorest soils in England, in Cheshire, where these rocks are covered by the drift, a fairly stiff deep soil of great fertility, resting upon porous subsoil is produced; and (3) that where the Keuper Marls are covered by the drift clay and sand (as over the greater part of the Cheshire plain), the soil resulting from the combined marls and drift bears some of the finest known pastures.

The *structure and composition* of the various beds of the Trias, and especially the sandstones, have formed subjects of careful investigation both microscopically and chemically by several members of the Society, largely with a view to the bearing upon the probable origin of the beds. Mr. G. H. Morton, on December 9th, 1885, read an important paper on "The Microscopic Character of the Triassic Sandstones of the Country around Liverpool," giving a careful description of 26 examples of sandstone from various localities and various horizons. The secondary crystallisation of quartz on the grains both in the pebble beds and the Keuper sandstones is described. He concludes that microscopic examination does not throw much light upon the position in the geological series of certain doubtful beds.

Mr. T. Mellard Reade, on November 10th, 1891, contributed a paper on "The Rounding of Sand Grains of the Trias as bearing on the Divisions of the Bunter," and described the component particles in Triassic rocks from many localities. His observations showed that the Keuper sandstones as a whole are less rounded in the grain than the considerably worn grains of the Bunter, with considerably more secondary deposition of silica and crystalline growth. This crystalline character and siliceous cement makes the Keuper sandstones generally the better building stone; but certain beds of Bunter sandstone, which show a similar large development of secondary silica, are even better for building purposes than the Keuper. On April 14th, 1896, Messrs. E.

Dickson, F.G.S., and P. Holland, F.I.C., contributed "Notes on Analyses of Permian and Triassic Rocks from the Neighbourhood of Liverpool," in which they show that the Storeton sandstone consists of grains bound together "either by infiltration and subsequent precipitation of dissolved silica, or by the close packing of the "grains with 'rock flour,'"; while the associated marls are for the most part composed of similar "rock flour," with some micaceous ferruginous clay, which suggests that possibly both sandstone and marl were derived immediately from the same parent primitive rock. Mr. Lomas on November 12th, 1907, read a paper on "The Mineralogical Constitution of the Storeton Sandstone," and described nine samples of the rock taken at different levels at intervals of about ten feet, the results generally confirming the observations in the paper by Messrs. Dickson and Holland.

In connection with the *chemical composition* of the Triassic beds, Mr. A. Norman Tate, F.C.S., on February 10th, 1863, showed that the colour of certain black patches in the sandstone were due to peroxide of manganese; while Mr. C. C. Moore, F.I.C., in a very complete paper on the "Chemical Examination of Sandstones from Prenton Hill and Bidston Hill" (February 8th, 1898), described a number of interesting dark brown concretionary masses (many in the form of tubes or pipes) in the Bunter Sandstone, containing a large proportion of hydrated ferric oxide; while black grains obtained from within the concretions contained marked quantities of the oxides of Cobalt and Nickel.

Speculations as to the *conditions under which the beds of the Trias were laid down* occur incidentally in a number of communications to the Society, as well as in several papers dealing directly with the subject or describing the existing conditions in localities which may throw light upon the question. Interest was stimulated by the paucity of the organic remains which are found in the beds, and by Ramsay's theory of these red rocks having been formed in inland salt lakes.

The subject was dealt with by Mr. Beasley in his Presidential Address in October, 1888, as far as regards the origin of the Bunter sandstone, describing it as "a very fit subject for investigation by this Society," although he added, "the enquiry is beset with great "difficulties. . . . . The absence of organic remains in "itself deprives us at once of one line of investigation "pursued with success in other formations, and we are "met at the outset with the necessity of accounting for "it. . . . . The theory of the marine origin . . . pre-"sents so many difficulties that it has been generally "discarded, so many things point to continental conditions "having prevailed in Triassic times in this part of the "world." He considered that the very persistent character of "false-bedding" throughout the Bunter series bore witness to a constant process of reassortment during the accumulation, and suggested the possibility that much of the re-assortment may have been aerial, the very well-rounded character of the sand grains (more readily produced by wind than by wave action) being quoted in support. In a later Presidential Address (October, 1905) on "Some Difficulties with regard to the Formation of the Upper Keuper Marls," Mr. Beasley recurs to the subject, and favours the action of the wind as an important factor in the production of the whole series of Triassic rocks, suggesting that the Keuper Marls may be constituted by the very fine dust (produced by the attrition of the wind-moved grains) carried to the edges of the desert region and there caught and deposited in shallow sheets of water.

Mr. W. Hewitt, B.Sc., in a Presidential Address, October, 1892, on "The Physical Conditions of the "Arato-Caspian region, as bearing on the conditions "under which the Triassic rocks were formed" dealt with the accumulation of great quantities of sand in those arid regions and its distribution by the wind. An important paper on "Desert Conditions and the origin of the British Trias" was read by Mr. Lomas on October 16, 1906, in which the whole subject is very fully discussed and it is shown that various features of our Triassic rocks, e.g., the lenticular beds of clay interbedded with the sandstones, with their rain pittings, desiccation cracks, &c., the occurrence of Estheria, the occasional occurrence of barytes, the absence of decomposition products where subsequent infiltration has been prevented, the false bedding, the horizontal sifting out of particles according to size, can all be paralleled by similar phenomena met with in existing desert regions.

Mr. T. Mellard Reade advocated another method of formation for the Bunter, viz., the accumulation in a tidal sea of considerable depth in basins or straits, the conglomerate beds being formed on the shore margins. This theory he quotes in his paper on "The Trias of the "Vale of Clwyd" (1890-91) where no pebbles occur, and "The Trias of Cannock Chase" (March 8, 1892) where the conglomerates are in great force. In an early session (1873-4) Mr. Reade had brought forward reasons for taking account of the tides both in the movement of material and erosion of the sea bed, in a paper on "Tidal "Action as a Geological Cause."

Faults and Slickensides.—The dislocations which the Triassic beds have suffered and the results of such movements force themselves upon the notice of observers. Dr. Ricketts, F.G.S., in his Presidential Address, October, 1872, refers to the principal faults of the district being mainly north and south, and having striated slickensides in the direction of the hade of the fault, while the secondary faults running in a general east and west direction are slickensided sometimes almost horizontally, but more frequently in a more or less oblique direction. He also refers to the common occurrence in the principal faults of a coarse cleavage or lamination of the "fault "rock" filling the fissure, in a direction parallel to the hade of the fault. Mr. Morton's description of a Geological Map of the Storeton Quarries (November 14, 1882) already referred to recorded 17 faults running nearly north and south, and five running east and west. In his paper on the section exposed in the opening out of the Lime Street Tunnel (November, 1883) Mr. Morton described the faults there shown, including the great fault which brings in the Keuper in the middle of Liverpool by a downthrow of about 600 feet. Mr. Beasley on April 10, 1888, read a paper on "Some irregularly slicken-"sided joints at Langdale Quarry, Birkenhead," in which an interesting example occurred of the throw of the fault being marked on the sheared faces by the trace of clay nodules cut through by the joint.

On March 12, 1889, an important paper was read by Mr. T. Mellard Reade on "Slickensides and Normal "Faults: their characteristics and cause," a subject to which he had paid particular attention in connection with his work on the "Origin of Mountain Ranges" (1886). He described the slickensides found in the New Red Sandstone as mostly possessing highly glazed striated porcellaneous faces, the grains of the rock being polished and the interstices filled with a "crystalline setting of "what might be taken for minutely-rifted glass . . . .

"the minute angular fragments of the broken grains "produced by the grinding of the walls of the fault "against each other." This he imitated by an experiment in which two pieces of fine grained quartzose sandstone were rubbed together under pressure. He shows that *normal* faults (as distinguished from reversed faults and thrust planes) are due to contraction (resulting on a large scale from a series of falls of temperature) and the re-adjustment resulting from the shearing off and settling down of wedge shaped masses of rock. He deals again with this subject in a particular case in his paper on "The Berwickshire Coast: a Study in Physical Geology" (1895-6). The Rev. F. F. Grensted, M.A., in a paper read Nov. 12, 1895, "A contribution to the dynamical "theory of the Craven Highlands" brought forward evidence from that area to support Mr. Reade's theory of the origin of both folding and faulting.

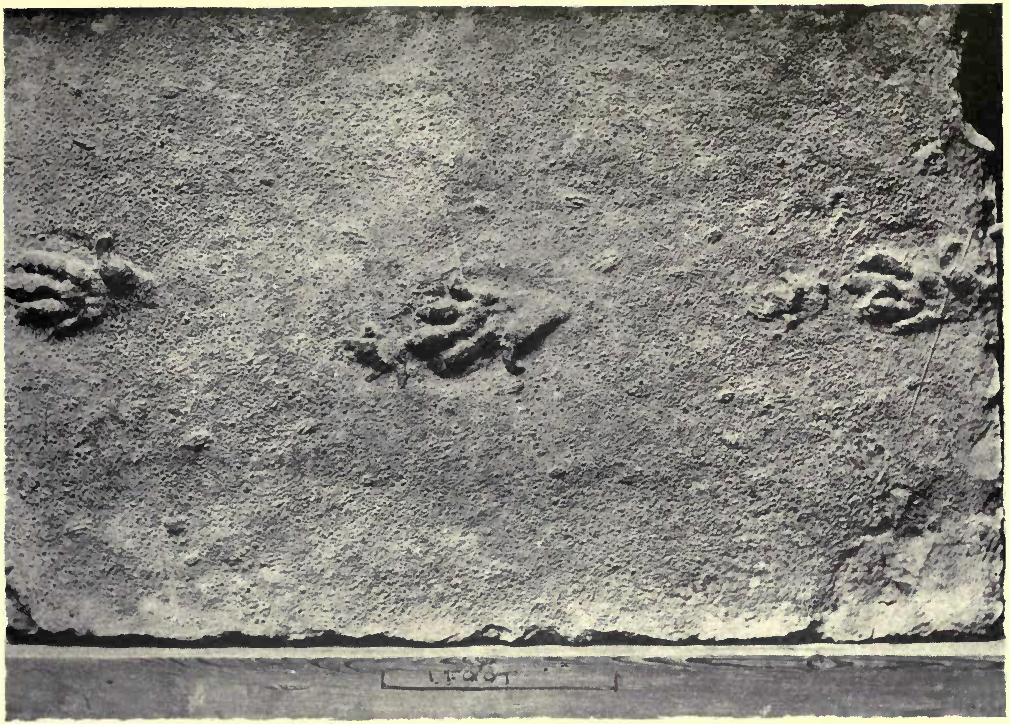
Mr. Lomas described (April, 1892) a series of "Faults exposed in a Quarry near Thingwall," and Mr. Lomas and Captain Dwerryhouse on April, 1893, described another series of "Faults exposed in Arno Quarry, "Birkenhead." In both cases the faults were divisible into three classes: (1) those with general direction N. and S., all having vertical slickensides; (2) those bearing approximately E. and W., all either horizontally slickensided or having little or no throw; and (3) those bearing in other than N. and S. or E. and W. directions, with oblique slickensides.

On March 14, 1899, Mr. Morton communicated to the Society a "Description of his Geological Map of Liver-"pool," on which he had recorded from his own observations, extending over many years, the position of 41 faults, with downthrows varying from a few feet to 1,000 feet in the case of the boundary fault between the Bunter and Keuper, and which running along Netherfield Road and

Shaw Street is indicated by the contour of the ground. He notes that the most intense faulting is in the Keuper where it has been dropped between the two boundary faults.

II.—THE STORETON FOOTPRINTS.

A reference to these fossil remains—which are by far the most important fossils of the immediate locality—first occurs in the Society's records of the fourth session, in a paper by Mr. G. H. Morton, F.G.S. (read on March 17th, 1863), "Description of the footprints of Cheiro-"therium and Equisetum found at Storeton, Cheshire." In this paper Mr. Morton first proposes the specific name of "*Storetonense*" for the particular animal whose footprints were found at Storeton, as also the name *Equisetites Keuperina* for the fossil plant found at the same place. (The original specimens from Storeton of both Cheirotherium and Equisetites were at the time of the reading of the paper contained in the geological collection in the Royal Institution, but the slab with footprints has since been removed to the Bootle Museum, while the specimen of Equisetites is now in the Liverpool Public Museum.) In his Presidential Address at the opening of the twelfth session (October 18, 1870) Mr. Morton gives a fuller reference to the discovery of these remains by Mr. John Cunningham, F.G.S., in 1838, an account of which was communicated by the Liverpool Natural History Society to the Geological Society of London and published in their Proceedings (Vol. III., p. 12). The position of the thin bed of marl in which the footprints occur is shown in the lithographed section through the Keuper at Storeton, which accompanies Mr. Morton's account of the Society's Field Meeting contained in the Proceedings for the fourth session.



CHEIROTHERIUM STORETONENSE (MORTON).

One of the Original Slabs described by Mr. J. CUNNINGHAM, 1838—now in the Bootle Museum. Specifically named by G. H. MORTON.—*Proc. L'pool Geol. Soc.*, 16*th March*, 1863.

Mr. H. C. Beasley, F.G.S., has devoted a large amount of attention to the occurrence and character of these footprints and has laid the results of his work before the Society in a series of papers, the first of which (read December 10th, 1895) was entitled "An attempt to "classify the footprints in the New Red Sandstone of "this District." He arranges the various types of impressions in 8 groups which he designates simply by the letters A to H, and gives a short description of the character of each group. Two years later (January 11, 1898) Mr. Beasley communicated some "Notes on "examples of footprints, &c., from the Trias in some "provincial Museums" (Chester, Warwick, Worcester and Shrewsbury), and added a ninth group; and in April 1902 two further groups designated K and L. Later still (November 11, 1902) he exhibited and described a series of six lithographed plates (published about 1839) of Footprints, a "seed," and other markings described as "Fucoids" but which it is suggested were probably due to water trickling over soft sand or mud.

In 1906 the working of the Storeton Quarries laid bare a considerable area of the "Footprint Bed," and the proprietor (Mr. C. Wells) took great pains to have a number of the most interesting slabs carefully raised and set aside so as gradually by weathering to disclose in excellent condition any impressions they bore. Numerous visits were paid to the quarry by Mr. Beasley, Mr. Lomas and other members of the Society, while a joint excursion with the North Staffordshire Field Club and the Liverpool Biological Society, was arranged to examine the specimens on the spot. As a result of a study of this large amount of additional material Mr. Beasley devoted the greater part of his Presidential Address in November, 1906, to a resumé of our present knowledge of the beds in which the footprints are found (together with ripple marks and desiccation cracks), and of the character of the impressions, of which there are at least 10 quite distinguishable varieties. Many of the Cheirotherium footprints show clear impressions of nails at the ends of the digits and of an integument covered with flattened circular tubercles.

[In Session 1907-8 Mr. Beasley described in detail a number of "Markings, other than footprints in the "Keuper Sandstones and Marls;" some of them probably of organic origin, e.g., tracks of invertebrates and casts of plants, others of inorganic origin such as rain pittings, pseudomorphs, ripples made by running water; the papers being illustrated with some excellent photographic reproductions.]

III.—GLACIAL DEPOSITS AND STRIÆ.

A great part of the immediate district is covered by a thick deposit of boulder clay containing smoothed and scratched boulders and shell fragments. Opportunities for studying these beds have occurred in numerous excavations in the clay for the purpose of brickmaking, or for docks or foundations, as well as in the clay cliffs which occur in several places on the shores of the estuaries of both the Mersey and the Dee. The sandstone rocks immediately underlying the clay have in many places, when newly uncovered, shown distinct evidence of having been rubbed and planed down, and marked with grooves and striæ, but from the character of the rocks these appearances do not as a rule last long after exposure. The description of these beds and striæ, the origin and character of the contained boulders and shells, and the conditions under which the beds were formed have proved a continuous source of interest and discussion throughout the whole period of the Society's history.

Just before the establishment of the Geological Society, Mr. G. H. Morton, F.G.S., described before the Literary and Philosophical Society (Session 1859-60) a striated rock surface discovered by him in a brickfield between Parkhill Road and the Dingle. His communication (printed in the Proceedings of that Society) is entitled "Traces of Icebergs near Liverpool." At the second general meeting of the Liverpool Geological Society (March 13, 1860) he exhibited "a number of "scratched boulders and shells collected by him from the "boulder clay at Kirkdale. The stones were intimately "connected with the grooved and striated surfaces of "the sandstone in the neighbourhood of Liverpool." Twelve months later (March 12, 1861) in a paper read before the Society on "The Pleistocene Deposits of the "District around Liverpool," Mr. Morton classified the Glacial Deposits in three divisions, viz., (1) Upper Drift Sand; (2) Boulder Clay; and (3) Lower Drift Sand, with a total average thickness of 100 feet, shells being found in both the boulder clay and the underlying sand. A year later (February 11, 1862), having discovered other striated surfaces in two localities in Kirkdale (and subsequently at Oxton), he described these in a paper "On the surface "markings near Liverpool, supposed to have been caused "by Ice," in which he suggests the grounding of icebergs as the probable cause of the striæ. It was no doubt partly owing to interest excited by the discovery of these surfaces and partly to the lively interest aroused by Professor Ramsay's paper "On the Glacial origin of certain lakes" read before the London Geological Society in March of that year, that Mr. Morton was led to examine the signs of glacial action in the Snowdon district, of which he gave an account to the Society in a paper "On the Ancient "Glaciers of Snowdon" on October 14, 1862. In October, 1866, he read a paper "On the presence of Ice in the

"Valley of the Mersey during the Post Pliocene Period," in which he expresses the opinion that the striations were due to the passage of a vast mass of ice down the valley of the Mersey. (A newspaper report of the meeting at which this paper was read says "The author advanced the "startling theory that Liverpool is situated upon the site "of an ancient glacier.") In January, 1872, Mr. Morton submitted a list of the "Shells found in the Glacial Deposits around Liverpool," the large majority being in the Lower Drift Sand; and on March 13, 1887, he gave a full tabulated list and description of the "Glacial Striæ in the "country around Liverpool." In this latter paper (which is his last paper before the Society dealing with the Glacial period) he goes back to the theory that the striæ (which vary in direction to as much as 65°) were caused by floating ice, grounding in a shallow sea.

The publication of Professor James Geikie's book "The Great Ice Age" in 1874 seems to have stimulated much local interest in this subject, the majority of the papers read during the session 1874-5 dealing with glacial phenomena and the causes to which they were due. Mr. Isaac Roberts, F.G.S., devoted his Presidential address in October, 1874, to the Phenomena of the Glacial Drift; in connection with which he exhibited a number of shells (many in a very perfect state) obtained by him from excavations at Linacre (described before the Society in April, 1871), boulders, and also specimens of boulder clay separated by mechanical analysis, from the results of which analysis he inferred that "the great mass "of the boulder clay of this locality seems to be composed "of the ground-up Keuper Shales and Bunter Sandstones." His examination of wide areas of boulder clay in the district over many years led him to question the existence of sufficient evidence for the division of the boulder clay into an upper and lower division separated by drift sand as proposed by Mr. C. E. de Rance.

Mr. T. Mellard Reade, F.G.S.—whose first paper on the subject (November 12, 1872), contained the first description of cross striations in the district (at Miller's Bridge, Bootle)—contributed in the "Glacial Session" (1874-5), the first of a series of carefully worked out papers on Glacial Geology; this paper being a description of "The Glacial and Post Glacial Deposits "of Garston and the surrounding district, with remarks on "the structure of the Boulder Clay" (December 18, 1874). The description of the beds exposed in the excavations for the Garston Docks refers to the included shell fragments, which the author considered as proof that the clay is "a "marine deposit," an opinion which he afterwards consistently maintained. He also describes the results of a careful examination of the number and character of the erratic blocks contained in a similar deposit at Great Crosby, where he estimated that in one instance the proportion of stones to the mass of clay was on an average about 1 in 900, while about 47 per cent. of the stones bore marks of ice action; and amongst these he first identified the syenite of Buttermere. Mr. Reade in subsequent sessions contributed a series of important papers describing his investigations into the drift beds of other localities for the sake of comparison or contrast with those of this district, e.g., the North coast of Ireland (Session 1878-9), the Clyde and Forth (Session 1879-80), the Southern Counties of England and Wales (Session 1880-81), Yorkshire (Session 1882-3), Moel Tryfaen area (1892-3), Dublin and Wicklow (1893-4), Mid-Wales coast (1895-6), Ayrshire (1896-7), Lune Valley (1901-2), and the North of the Isle of Man (1905-6).

In Jan. 1877, Dr. C. Ricketts, F.G.S., read a paper, "The Conditions existing during the Glacial Period; with “an account of the Glacial Deposits in the valley between “Tranmere and Oxton,” in which he records Glacial striæ from that locality, and describes the beds of sand and clay; referring specially to the finding in the clay, here and there but not very commonly, flints which he considered were derived from the chalk of Antrim. In the session 1878-9 he described “Some Remarkable Pebbles from the “Boulder Clay” which he regarded as showing signs of weathering, sometimes to the extent of completely separating the stones into two or more parts (remaining in apposition), the weathering having taken place after glaciation and before the pebbles were embedded in the clay. A second paper on a cognate subject, “Split and “other Boulders,” was communicated by him in session 1880-81. For his Presidential Address in Session 1890-91, Dr. Ricketts took as his subject “Some Phenomena “which occurred during the Glacial epoch,” and summarised his observations on the weathered and split boulders, the occurrence of flints and specimens of the hard Antrim chalk, the decomposed granite and greenstone boulders found in the boulder clay, which latter he considered were dropped in the clay in a frozen condition from floating ice, as was also the case with the frequent pockets of loose sand.

Mr. Daniel Mackintosh, F.G.S., who became a member of the Society in 1877-8, in his address as President in October, 1882, referred to the results of his examination of the high level marine drifts which he had discovered on Minera mountain, and which he had described along with other similar beds in a paper published in the Quarterly Journal of the Geological Society in the previous year. In his second Presidential address (Oct., 1883), on “The time which has elapsed since the close of “the Glacial Period,” he tried to show from the fresh appearances of glaciated rock surfaces, from the heights of the pedestals on which stand the Arenig boulders about Llangollen, and the Silurian boulders on Norber Scar, that an interval of perhaps not more than 6,000 years had elapsed since that period.

In session 1884-5, Mr. H. C. Beasley, F.G.S., described a striated surface at Poulton and the relations of those striæ to others at Flaybrick, Wallasey and other places in the neighbourhood. The directions (which he had transferred to sheets of the six-inch Ordnance Map) showed " a very general parallelism of striæ in a direction " within a few degrees of 30° W. of N. ;" and he concluded that they were " due to the action of a sheet of ice " covering a very considerable area and of considerable " thickness," with indications of the movement being towards N.N.W. In his Presidential Address in October, 1888, when briefly summarising some of the results of observation of striæ and disposition of the beds and the problems still requiring to be worked out, he expressed himself as more inclined to believe in floating icebergs as the cause of many of the observed phenomena.

In the session 1888-9, the Society at its meeting on February 12, 1889, decided to form a BOULDER COMMITTEE, consisting " in the first instance " of members of the Society " to record and report upon boulders in the neigh-" bourhood of Liverpool." The objects of the Committee were stated to be " (*a*) to investigate the occurrence, " character, origin and transport of boulders or ' erratic " ' blocks ' from half a cubic foot in size upwards, and their " bearing on questions of glacial geology ; (*b*) to record the " position of the boulders on a suitable map ; (*c*) to sum-" marize reports on local boulders which have already " appeared in the transaction of its own or kindred " Societies." (In 1891 the " North-West of England " Boulder Committee " was formed, which afterwards developed into the "Glacialists' Association," and of which Mr. Lomas and some other members of the Society's Boulder Committee became active members.) The first Report of the Boulder Committee was presented by Mr. J. Lomas (who was in fact its most active member) on December 8, 1891—a "Report "on the Glacial Deposits between Dingle Point and Hale "Head," on the north shore of the estuary of the Mersey. Beds of clay (often very shelly) and sand are described in some detail, including a "fine example of a 'ground "'moraine,' and an example of a 'striated pavement';" 136 boulders lying on the shore are tabulated as to position, size and constitution, the largest measuring 8 feet in its longest direction, and 81 per cent. being identified either as Lake District Andesites or Scotch Granites. In the following session (Dec. 13, 1892) Mr. Lomas and Capt. A. R. Dwerryhouse jointly presented a second report describing "The Glacial Deposits on the Shore of the Mersey "between Hale Head and Decoy Marsh," including another example of "striated pavement." The boulders (more than 200) recorded in this enquiry were included in the report of the Erratic Blocks Committee of the British Association. The authors concluded that "all the facts "are consistent with the passage of a great sheet of land "ice over the district," and [they say] "we have observed "nothing which would tend to support the theory that the "deposits were formed during a period of great sub-"mergence."

From this time the papers and discussions on Glacial Geology before the Society were mainly directed to the friendly rivalry of the two contending schools, viz.: those who advocated the extreme land ice theory (led by Mr. Lomas) and those who maintained the theory of the formation of the boulder clay under marine conditions during a period of submergence, with Mr. T. Mellard Reade as protagonist.

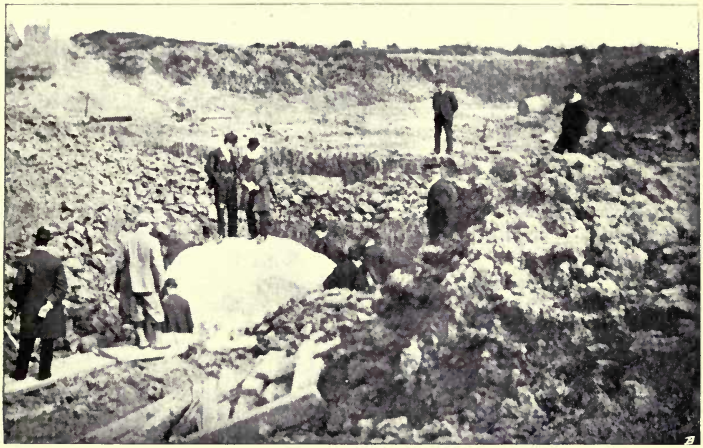
Mr. Lomas communicated to the Society papers detailing personal observations during visits paid by him to the Faroe Islands ("Geology of the Faroe Islands," 1894-5), and to Switzerland ("Observations on recent "Glacial Striæ in Switzerland," 1895-6; and "Notes on "Swiss Glaciers," 1898-9). In the first of the Swiss papers he described striæ observed under and near the end of the Gorner Glacier, and of which he took rubbings; and he claimed that the varieties of striæ met with on the rocks about Liverpool can be matched by the striæ observed in connection with this modern glacier. The paper by Mr. L. Cumming, M.A., in 1889-90, "Notes on Glacial "Moraines," with notes on certain features to be observed in modern glacial moraines in Switzerland, Austria and Norway; the paper by Mr. E. Dickson on "Mud "Avalanches" (1891-2), in which accumulations of débris simulating glacial moraines are described, and a further paper by Mr. Cumming in 1892-3, "Some "observations on Mountain Débris," calling attention to somewhat similar accumulations in the form of mud cones or fans in the Dauphiné district, should also be noted.

Mr. Reade in a very detailed paper on "The Drift "beds of the Moel Tryfaen Area of the North Wales coast" (November, 1892) set out at length his arguments in favour of the marine origin of these beds during submergence, and amongst other evidence for this he quotes the presence of extremely well-rounded sand-grains (some with quite a brilliant polish) in the boulder clay and associated sand beds, both of the low level marine drift and also of the Moel Tryfaen sands.

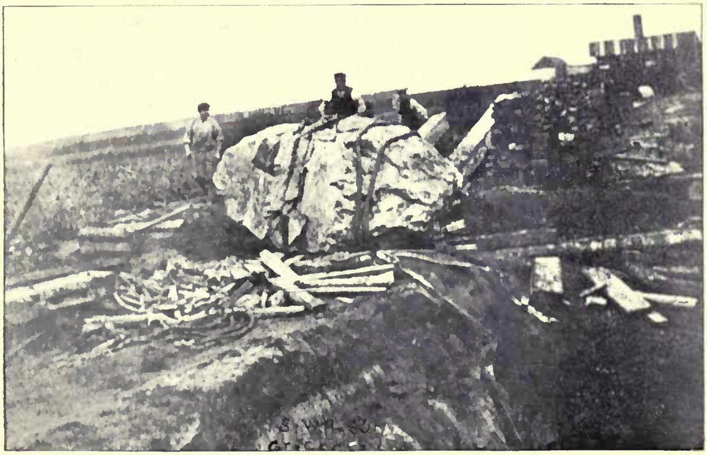
In a paper which he contributed jointly with Mr. T. W. Davies, C.E., April, 1895, ("Description of the strata "exposed during the construction of the Seacombe Branch "of the Wirral Railway") an interesting section of the boulder clay was described showing a division into a top and bottom clay separated by a bed of sand and some gravel containing a number of clay balls, the sand bed being described as a "shore line" and believed to indicate shore conditions. The upper beds of the Triassic rocks exposed in this section under the boulder clay were noted to have been apparently pushed forward in a south-easterly direction after having been planed and striated. In this paper there is given a considerable list of foraminifera (described by Mr. Joseph Wright, F.G.S.) both from the sand and the clay. In other papers ("Foraminiferal Boulder Clay at Great Crosby," Nov., 1895, "Notes on some specimens of Lancashire Boulder "Clay," Jan., 1905, and others), Mr. Reade submits lists of Foraminifera, determined by Mr. Wright, from Glacial Clays and Sands, and regards the presence of Foraminifera as further evidence of the marine origin of these beds under fairly quiet conditions.

Mr. Reade also communicated to the Society careful descriptions of certain large boulders met with *in situ* in the boulder clay, e.g., Session 1887-8, "Notes on a large "boulder found in driving a sewer heading in Oxford "Street, Manchester," and Session 1898-9, "The Gypsum "Boulder of Great Crosby." The latter stone, weighing about 18 tons, after being carefully observed, measured, oriented, and noted *in situ*, was extracted and placed with similar orientation on the surface of the ground in an open public space in Great Crosby.

In the last of his six Presidential Addresses ("The "Present Aspects of Glacial Geology" October, 1896),



The Boulder in Situ. (*Photographed on the occasion of a Field Meeting of the Society, June, 1898.*)



The Boulder being Pulled Up an Inclined Plane.

THE GYPSUM BOULDER OF GREAT CROSBY,

Mr. Reade gives a valuable resumé of the views to which he had been led by a long study of these deposits, both in the district about Liverpool and in other localities, together with a list of the 44 published papers in which he had recorded his observations.

Mention must be made of the valuable series of papers communicated by Mr. E. Dickson, F.G.S. (in some cases jointly with Mr. P. Holland, F.I.C.), on observations made in Switzerland on glacial and similar accumulations, and especially on the nature of the finer materials carried away by glacial streams. In joint papers by these authors, "Notes on the Examination of "water and sediment from the River Arveiron, near "Argentière" (Feb. 11, 1890), "Observations on "Moraines and Glacial Streams in the Valley of the "Rhone and near Grindelwald" (Dec. 9, 1890), and "Examination of Glacial Waters and Deposits from the "Rhone Valley and near Grindelwald, and of Glacial "waters from near Chamounix" (April 14, 1891), they show that the fine grey mud carried away from under the glacier is not a true clay, but that it is composed of "potentially clay forming substances, the chemical "changes whereby clay is produced have not yet taken "place." Mr. Dickson in his second Presidential Address (Oct. 9, 1894), points out the bearing of this and similar questions on the origin of our local boulder clay. In a later paper "Notes on some of the small Glaciers and "Glacial Deposits near the summit of the Furka Pass and "a comparison with similar deposits in the English Lake "District" (read Jan. 13, 1903, but printed along with the Proceedings for Session 45), attention is called to the part played by snow, snow slopes, and snow avalanches in the transport of débris.

IV.—POST-GLACIAL BEDS.

The sea shores of South West Lancashire and Cheshire, the shores of the estuaries of the Ribble, Mersey and Dee, and the valleys of smaller rivers show a series of deposits lying in most places on the Boulder Clay. These deposits, as they occurred on the Cheshire shore, were briefly described by Mr. G. H. Morton, F.G.S., in a paper read during the second session (March 12, 1861) on "The "Pleistocene beds of the District around Liverpool," and again in December, 1862, in an account of the Society's Field Meeting at Leasowe. Mr. C. Potter, on December 15, 1868, in his paper "Observations on the Cheshire "Coast," gave a fuller description of the various beds, including a lower and an upper peat and forest bed, composed largely of fresh water plants (Iris, &c.) separated by a bed of marine bluish clay or silt which he called the Scrobicularia Clay; the uppermost peat bed being succeeded by several thin beds mostly of sandy silt, capped by a layer of surface soil from which a number of Roman and Mediæval relics were obtained. In his Presidential Address at the beginning of the following session (Oct., 1869) Mr. Morton contested the accuracy of Mr. Potter's description of the beds and his conclusions.

On November 14, 1871, Mr. T. Mellard Reade, C.E., F.G.S., in his first paper before the Society, entitled "The "Geology and Physics of the Post Glacial Period as shown "in the deposits and organic remains in Lancashire and "Cheshire," gave a very full and systematic account of these post glacial beds, the result of a considerable amount of careful observation and the collection of data specially accessible to him in connection with his professional work as a civil engineer. The paper was accompanied by a valuable coloured geological map showing the distribution of the deposits, and a series of coloured sections drawn accurately to scale. The post glacial beds were shown to lie upon a post glacial beach cut in the Boulder clay, and were confined for the most part to the area below the 25 feet contour line. During a period of elevation the Boulder clay was eroded and the valleys of the Alt, Douglas, Birket, &c., cut out; being afterwards partly filled and levelled up by marine deposits, &c. Mr. Reade divides the post glacial beds above the boulder clay in ascending order as follows: (1) Washed Drift Sand (previously described by Mr. Morton as Upper Drift Sand) derived from the boulder clay and indicating a period of depression; (2) The Inferior Peat and Forest Bed, containing stumps and trunks of trees, formed as a land surface during a period of elevation; (3) A laminated blue marine clay or silt formed during submergence, called by him the "Formby and Leasowe "Marine Beds," containing remains of the horse, red deer, &c., and in which a human skeleton had previously been found at Leasowe; (4) The Superior Peat and Forest Bed indicating another land surface and period of elevation; succeeded by (5) Recent silts of a more arenaceous nature, overlain by (6) Blown Sand, which in places forms dunes rising to 75 feet above Ordnance datum and having a width in places of 3 miles from high watermark.

Mr. Reade returned to the subject on several subsequent occasions describing fresh sections exposed from time to time which disclosed new facts or confirmed his previous conclusions. Thus on March 10th, 1885, he described "A Section across the River Douglas at Hesketh "Bank—a Post-Glacial deposit in which were human "bones," the bones referred to being found 20 feet below the surface of the marsh, in a gravelly silt which was probably posterior in age to the main peat bed. And in almost his last paper contributed to the Society (Dec., 10, 1907) on "Post Glacial Beds at Great Crosby as disclosed "by the new out-fall sewer" he took advantage of a long trench excavation to complete the map of the alluvial plain of South-West Lancashire, which accompanied his first paper in the session 1871-72. In this paper he showed that the peat and forest beds exposed on the shore were connected with the inland peat; which latter is underlaid by beds varying from a fine clay to a sandy silt, with abundant foraminifera, and continuous with the Formby and Leasowe Marine Beds underlying the Superior Peat and Forest Bed.

At the same meeting (Dec. 10, 1907) Mr. J. Lomas, F.G.S., described a bed of peat exposed in excavations in the Union Dock, which deposit was apparently composed entirely of marine plants (laminaria predominating) which he thought might have been accumulated in a sheltered bay in the old estuary of the Mersey.

Mr. E. Dickson, F.G.S., in two papers: "Notes on the "Excavations for the Preston Docks" (Feb. 8, 1887), and "Geological Notes on the Preston Dock Works and the "Ribble development scheme" (Feb. 14, 1888) gave a full description of the post glacial beds of the Ribble estuary consisting of River Silt, Sand, and Gravel, with Peat in places, the sand and gravel containing trunks of trees evidently brought down by the river. During the excavations a considerable number of remains of Urus, Red Deer, Horse, &c., were found, together with several human skulls and a boat or canoe. Mr. Dickson also, in a paper in December, 1899 ("Notes on Glacial and Post "Glacial Deposits near Southport"), gives an account of the sand and peat beds which occupy the site of the old Martin Mere, with an account of the probable extent of the mere.

V.—THE SUBMERGED FOREST BEDS.

Of all the subjects that have come before the Society, the origin of the old peat and forest beds which occur on the shore between tide marks in Wirral and South-West Lancashire has excited the greatest amount of feeling, and was responsible in the earlier years of the Society's existence for some heated discussions and strained relations between certain of the members. Long before the establishment of the Society the beds at Leasowe on the Cheshire shore had been described as an example of a Submarine Forest, e.g., by Mr. John Cunningham, F.G.S., before the British Association at Liverpool, 1854; and these and similar beds met with in excavations for the Liverpool and Birkenhead Docks, were described in papers read before the Literary and Philosophical Society from 1846 onwards.

In the second session (March 12, 1861), Mr. G. H. Morton, F.G.S., described these beds in a paper "On the "Pleistocene Deposits of the District around Liverpool" and referred to the trees as having grown in the positions in which they now occur when the surface, however, was at a higher level; remarking that "the subsidence of the "lowest submarine forests probably caused a considerable "extension of the River Mersey about the time of the "occupation of Great Britain by the Romans." In the following year (Sept., 1862) Mr. Morton conducted an excursion of the members to "the interesting sections of "the Submarine Forest Beds at Leasowe Lighthouse and "Dove Point."

The theory that the "so called Forest Beds" were derivative, and that the contained erect stumps of trees were not *in situ*, was put forward by Mr. Joseph Boult in a paper read before the Liverpool Polytechnic Society in 1865. This view was maintained by Mr. Charles Potter in papers read before the Liverpool Geological Society on February 12, 1867, “Observations on the Submarine “Forest and the sea shore at Dove Point, Cheshire,” and in December of the same year “Observations on the Shore “between the Mersey and Dee.” Neither of these papers was printed in the Proceedings; but at the first meeting of the following session (Oct. 13, 1868) the President (Mr. R. A. Eskrigge, F.G.S.) in his address states, “The most lively interest of the [past] session arose “from a paper by Mr. Potter, entitled ‘Observations on “‘the shore between the Mersey and the Dee.’ We much “regret to find this valuable communication omitted from “our published Proceedings, as it evinced unwearied “diligence in the collection of facts and considerable “ingenuity in support of the conclusion towards which it “was mainly directed, viz., that the so-called ‘forest bed’ “at Dove Point was formed from drifted materials, and “that the trees whose stumps and roots are now to be seen “there, did not grow on the spot.”

A paper by Mr. C. Potter “Observations on the “Cheshire coast” (read Dec. 15, 1868), containing in a condensed form the facts and arguments contained in his previous papers, was published in the Proceedings for Session 1868-9, in which he sets forth at length his reasons for believing that the tree stumps are not in the position in which they grew, but that they had been broken off by storms and floated—both detached trunks and butts—into the position in which they are now found.

Mr. Morton, in his Presidential Address at the beginning of the following session (Oct., 1869) took the somewhat unusual course of controverting Mr. Potter's paper, explaining his action by the statement that “Circum-“stances, however, seemed to require some decided “expression from this chair regarding the origin of the “Submarine Forests on our coasts.” At a later meeting in

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the session, (March, 1870), Mr. Potter read a paper "Further Observations on the Cheshire Shore, with a "review of past investigations," which did not, however, appear in the printed Proceedings.

Mr. T. Mellard Reade, F.G.S., in his paper on the Post Glacial beds (Nov. 14, 1871) describes two "Peat and "Forest Beds," each containing trees and separated by a bed of laminated blue clay and silt with marine shells. He describes the roots of the stumps in the Superior Peat and Forest Bed at the Alt mouth as seen, when exposed by denudation, striking down deeply into the blue clay below, which he regards as conclusive evidence of the trees having grown *in situ*. In a later paper, "Some further "Notes on the Submarine Forest at the Alt mouth" (March 12, 1878), in which Mr. Reade gives a very detailed description of these Peat and Forest Beds, and of the contained trees, he refers to the fact that in the presence of several members of the Society and other gentlemen, he had had one of the trees carefully dug up and had demonstrated that the roots penetrated the underlying blue clay. (This digging up of the tree was described by him in a paper printed in the Quarterly Journal of the Geological Society, Vol. XXXIV., pp. 147-8. The members of the Society present were R. A. Eskrigge, F.G.S., W. Semmons, T. J. Moore, C.M.Z.S.L., A. Morgan, E. M. Hance, LL.B., E. Foster, and W. Hewitt, B.Sc. Mr. Reade in the paper referred to writes, "Every one of the party was fully satisfied that the stump "was in the position in which it had grown.")*

Later (Dec. 11, 1888), Mr. Morton described a Forest bed with standing stumps of trees at the Stanlow Marsh, on the shores of the Upper Mersey estuary, in a paper entitled "Further Notes on the Stanlow, Ince and Frodsham Marshes."

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* At a Field Meeting at Leasowe, on the Cheshire Shore, in 1866, Mr. G. H. Morton had employed two men to dig round some of the standing tree stumps to expose their roots.

VI.—THE ESTUARY OF THE MERSEY AND THE FORMER COURSE OF THE RIVER.

Before the establishment of the Society there had been various speculations as to the former course of the Mersey, arising from the fact that the Roman writers in their accounts of this part of the coast, while mentioning estuaries apparently corresponding to the present estuaries of the Dee and the Ribble, seemed to ignore the now much more important and more navigable estuary of the Mersey. It had been suggested that the upper Mersey had formerly discharged its waters into the sea either (*a*) by way of the Stanlow Marshes and the low lying land along which the Shropshire Union Canal runs from Ellesmere Port into the estuary of the Dee below Chester, or (*b*) by way of Wallasey Pool into the sea at Leasowe.

The first paper on the subject presented to the Society was one by Mr. Robert Bostock in Session 1869-70, "The Mersey and the Dee—their former channels and "change of level." From the position of several towns and villages (Poulton, Meols, &c.) of which the sites were originally chosen with reference to the shore line, from the position of the ford at Chester, and on other grounds, he argues that there has been no marked change of level for "several thousand years." He strongly controverts the idea of the Mersey having formerly followed either of the routes referred to above.

Mr. T. Mellard Reade, F.G.S., in January, 1873, in his paper on "The Buried Valley of the Mersey," showed from the records of a large series of borings that a deep pre-glacial river gorge exists under the town of Widnes, which was the former channel by which the Mersey passed from its upper to its lower reaches, instead of the present course through the much higher Runcorn Gap. He inferred that the continuation of this former deeper river channel in the solid rock might exist in the lower part of the estuary opposite Liverpool, although at the present time partly filled up by glacial drift, and expressed the hope that the Mersey Tunnel, then being constructed, might throw some light on the matter. He satisfied himself that Wallasey Pool was neither the pre-glacial nor the post-glacial mouth of the Mersey. Twelve years afterwards (Jan. 13, 1885), Mr. Reade in his paper on "The Mersey "Tunnel: its Geological aspects and results," announced that the tunnel works had, at about 300 yards from the Liverpool side, passed for about 100 yards through boulder clay filling a deep rock valley, such as he had inferred to exist. The fact that the depth of this valley was not so great as the portion of the buried valley under the town of Widnes he accounted for by differential subsidence.

In the interval between Mr. Reade's two papers, Mr. Morton had, in a Presidential Address at the opening of the 29th Session (Oct., 1887), dealt with the question of the Mersey, pointing out that it is necessary to distinguish between the Mersey as a river and as an estuary. As a river he did not see any strong reason for supposing that it ever ran into the sea at any other place than its present mouth, and was as such no doubt known to the Romans; but owing to subsidence (evidenced by the submerged forests, &c.) and by gradual encroachments of the sea (down to, perhaps, the 14th century) the estuary has since been formed.

In the following session (Nov., 1888), Sir James Picton, F.S.A., in a paper on "Notes on changes in the "surface of the land in and about Liverpool," suggested that while the estuary of the Mersey had been sinking, that of the Dee had been slowly rising, the neutral axis of the movement being situated along the middle of the Wirral peninsula.

Mr. J. Lomas, F.G.S., in his paper on "The Coasts of "Lancashire and Cheshire" (Nov. 10, 1903), argues that "the present course of the Mersey from Runcorn to the sea "is very probably a case of post-glacial diversion; the "original exit is clearly defined from Ince across the "southern end of the Wirral Peninsula to the sea." But the author in this paper is dealing with post-glacial conditions only, and with the eastward drainage of this district which he believed to have followed immediately on the close of the glacial period; and he suggests that instead of Wallasey Pool having been a former outlet of the Mersey it is "more "likely that the Great Float is the old channel which "carried the easterly drainage from the [ancient] Leasowe "Mere."

In connection with this section it may be well to note the important paper by Mr. E. Dickson, F.G.S., on "The "Ribble Estuary" given as his Presidential Address in Oct., 1893; and his previous paper, "Geological Notes on "the Preston Dock Works and Ribble Development "scheme," February, 1888.

VII.-CHANGES IN THE TOPOGRAPHY OF THE DISTRICT.

"Notes on the Topography of Liverpool" formed the subject of a paper read by W. Hewitt, B.Sc., on January 12, 1886, in which by the aid of a specially constructed topographical model the position of the old stream courses were traced, also the position and conformation of the ancient peat moss on the site of the old "Moss Lake," and the old Pool or Creek. Other features which had already disappeared or were rapidly disappearing were recorded.

Two sessions later the subject was discussed by Mr. G. H. Morton, F.G.S., in his Presidential Address (Oct. 11, 1887), in which he gave his personal recollection of several localities which had suffered considerable change in their surface configuration in connection with the growth and extension of the town; noting, for example, the constant tendency to remove inconvenient ridges and to fill up depressions, the excavation of quarries and their subsequent filling up and covering with houses, and the waste margin of brickfields in the boulder clay on the outskirts constantly receding before the extending boundary of new streets and houses. He notes also that old views of the town show a well marked ridge of undulating hills, running approximately North and South, just behind the old town, formed by a band of Keuper Sandstone about half a mile wide, with a more regularly outlined background formed by the higher elevation of the Pebble beds lying more to the East.

In the following session Sir James A. Picton, F.S.A., Liverpool's local historian, read a paper (Nov. 13, 1888) entitled "Local Historical Changes on the surface of the "Land in and about Liverpool," in which he describes the courses of former streams, the levelling of former rocky eminences, &c. He mentions the slope of the land from the ridge forming the high lands at Everton, Low Hill, and Edge Hill, as being interrupted by two ancient sea margins, one near the summit of William Brown Street (where in the excavations for the Picton Lecture Hall a "marginal deposit of pure white sand without a boulder "or pebble" was found), the other constituting the flat ground which was the site of the ancient Moss Lake.

The Topographical features of a wider area were discussed by Mr. J. Lomas, F.G.S., in his paper on "The "Coasts of Lancashire and Cheshire: their Forms and "Origin" (Nov. 15, 1903). He refers to the ancient swamps and meres which were left on the final disappearance of the ice sheet, held up by the irregular disposition of the boulder clay—Tarleton Moss, Martin Mere, Barton Moss, Simonswood Moss, Chat Moss, Ince Marshes, Leasowe, &c.—all probably draining to the east. He also refers to a series of dry valleys, which may be seen at Anglezark, Rivington, Bury, &c., which he regarded as former drainage channels along the margin of the ice. Wallasey Pool, Bromborough Pool and the ancient Liver-pool are described as drowned river valleys due to post glacial subsidence. He states that there is reason for thinking that the dunes at Formby have formed since the 14th century, and that the spit of sand at Formby Point—of relatively recent origin—is an accumulation of material brought down by the Mersey and the Ribble.

Mr. E. Dickson, F.G.S., contributed an interesting discussion on the position of the old Martin Mere and of the character of the beds occupying its site, in his paper "Notes on Glacial and Post Glacial Deposits near Southport," read December 12, 1899.

VIII.—THE LOCAL WATER SUPPLY.

Several papers brought before the society in its earlier sessions dealt with the question of the supply of water from the public wells sunk in the Triassic Sandstones. In the early part of last century the Liverpool water supply was entirely derived from shallow wells in the sandstone, which were gradually closed as the town extended, and several deeper wells were sunk. In 1864-5 there was a scarcity of water in the town and a great deal of public discussion on the subject of the supply. The first paper in the Proceedings dealing with the subject was presented about this time by Mr. G. H. Morton, F.G.S., on November 14, 1865, "On the position of the

"Wells for the supply of Water in the neighbourhood of "Liverpool," in which he stated that the selection of the sites for the earlier public deep wells was made in the absence of a true knowledge of the succession of the strata and the position of the great faults.

Mr. Robert Bostock followed, January 12, 1869, with a paper on "The New Red Sandstone as a source of Water "Supply," in which he showed that the rainfall in the area was not sufficient to account for the yield of the wells (especially in Cheshire), and inferred that the bulk of the water drawn from the wells was derived by infiltration from the sea, the saline matter being for the most part removed mechanically as the water passed through the pores of the sandstone.

Mr. Isaac Roberts, F.G.S., took up the question in a paper read on March, 16, 1869, "On the "Wells and Water of Liverpool," contesting the theory of some members of the Society that the water obtained from the sandstone was derived from distant sources in the hills of Wales or Cumberland. He showed from a consideration of the microscopic characters of the local sandstone rocks, from the result of experiments made by himself as to the rate of flow of water through such rocks under various pressures, from his personal experience and observations in sinking and deepening wells, and from the composition of the dissolved mineral substances contained in the well waters, that there could be little doubt that the water was derived for the most part by infiltration from the sea, that the supply was practically inexhaustible, but by continued pumping the water becomes more and more brackish, and ultimately would have the same salinity as that of the sea. Another paper by the same author (April 11, 1871) on "The effect "produced by Red Sandstone upon Salt Water" contained further evidence confirmatory of his previous conclusions.

Mr. T. Mellard Reade, F.G.S., who had served as a member of a Committee of the British Association "for "investigating the circulation of the underground waters "in the New Red Sandstone and Permian formations "of England," read a paper on January 8th, 1884, detailing the results of his own "Experiments on the "Circulation of Water in Sandstone," dealing mainly with the amount of water which bars of Runcorn and Everton Sandstones used for building could contain, and the rate at which water moved through the stone under the action of capillarity. He showed that a specimen of ordinary Runcorn Sandstone measuring one cubic foot could absorb 3·24 quarts of water; and as a practical and professional application of this he added "A red sandstone "house may be a very handsome building, but then it may "be holding tons of water in its pores!"

On one of the excursions of the Society members descended wells sunk in the Triassic Sandstone, (viz., at Borough Road and Spring Hill, Birkenhead) under the guidance of a member of the Society, Mr. W. A. Richardson, C.E., Water Engineer for Birkenhead; walking along the various headings and noting the manner in which the water issued with considerable force from fissures in the rocks.

IX.—PAPERS ON OTHER SUBJECTS.

The interest of the members of the Society has extended to geological problems connected with localities outside the special area, and to subjects of a general rather than a local character. These have been brought before the Society in communications from various members, who have made the questions matters of special study or have had an opportunity of working in some distant and interesting locality. A very brief notice only of some of these communications is possible.

Papers on the **older rocks** comprise two by Dr. H. Hicks, F.G.S., on the district of St. David's, 1863-4, and 1868-9; a paper by Mr. T. Mellard Reade, F.G.S., on a personal examination of the same district, 1887-8; a paper on the Society's excursion to the North Coast of Anglesey, by Mr. Reade, 1889-90; and another by Mr. E. Dickson, F.G.S., and Mr. P. Holland, F.I.C. (1889-90), on an examination of rocks collected on the same excursion; also a "Sketch of the Archæan Geology of Anglesey," by Dr. C. Callaway, F.G.S., in 1900-01, and a paper on "The Ordo-"vician Rhyolites of Nant Ffrancon," by Mr. C. B. Travis, 1908-9. Dr. Callaway in 1896-7 in "A Criticism on the "chemical evidence for the existence of organisms in the "oldest rocks" argues that the evidence does not justify a positive conclusion. The structure and chemical composition of some of the older slaty beds are very fully dealt with in two papers by Messrs. Reade and Holland, on "The "Phyllades of the Ardennes, compared with the slates of "North Wales," 1897-8, and 1899-1900, and a further paper on "The Green Slates of the Lake District, with a "theory of Slate Structure and Slaty Cleavage," 1900-1.

A full description by Mr. Morton of the Lower Silurian beds in the neighbourhood of Shelve, Shropshire, with a description of the mineral veins of the same district, was printed as an appendix to the Proceedings for 1868-9; a preliminary paper on the same district having been read by him at a meeting in the second session (1860-61), and a special paper on the Graptolites found in certain of the beds, in 1876-77.

A paper on "The Bala Limestone and its "associated beds in North Wales" was read at an early meeting of the Society in 1863-4, by Mr. D. C. Davies, of Oswestry, with a list of fossils from the same beds in the following session, 1864-5. Mr. T. Mellard Reade also deals with the Silurian, Old Red, and Carboniferous rocks in his paper on "The Berwickshire Coast: a "study in physical Geology," 1895-96.

Mr. G. H. Morton's papers on the **Carboniferous** Limestone and Millstone grit of North Wales represent the results of the work of many years and fill many pages of the earlier Proceedings. They are preceded by a paper in 1873-4 giving a "List of Works relating to the Carboni-"ferous Limestone and Millstone grit of North Wales." Then follow memoirs on the Llangollen district in sessions 1875-6, 1876-7, and 1877-8; Flintshire, 1881-2, 1882-3, 1885-6, 1886-7; Vale of Clwyd, 1896-7, 1897-8; Anglesea, 1900-01. The palæontology of these formations is dealt with in part in two separate papers in 1868-9 and 1886-7. There is also a paper on the Carboniferous Limestone of Belgium, session 1882-3, following a visit by Mr. Morton to that country; and one on "The Microscopic Character "of the Cefn-y-fedw Sandstone of Denbighshire and "Flintshire," 1886-7.

Dr. C. Ricketts, F.G.S., also presented several papers on the Silurian and Carboniferous beds, e.g., "The Geology of the neighbourhood of Ingleborough," 1868-9, "On the Carboniferous Limestone near Skipton "and in North Derbyshire," 1879-80, "The base of the "Carboniferous Limestone," 1886-7, and "On some con-"ditions existing during the formation of the older "Carboniferous Rocks." 1892-3.

The "**Permian** Conglomerate and other Palæozoic "rocks to the North of Morecambe Bay," 1888-9, and "The "Permian Conglomerate of the Vale of Eden" (1893-4), are the subjects of two papers by Mr. J. J. Fitzpatrick. A remarkable "Moraine Conglomerate," (supposed to be a glacial deposit of the Palæozoic age), and the associated Palæozoic rocks, are described by Mr. E. Dickson, F.G.S., in a paper "On some of the Geological features of the "neighbourhood of the Varanger Fjord, Arctic Norway," 1896-7. And in this connection also may be mentioned the paper by Mr. Lomas in Session 1905-6 on "The Dwyka "of South Africa," a very ancient conglomerate of glacial origin. Mr. E. Dickson's papers (1892-93 and 1894-5) on the section of the Permian exposed in Skillaw Clough have been already mentioned.

The volcanic rocks of the Auvergne district are dealt with by Mr. E. Dickson in a paper on "A visit to "Auvergne, 1898-9, and in an earlier paper (1888-9), Mr. Dickson, in conjunction with Mr. P. Holland, contributed an account of a chemical and microscopical examination of "Some Volcanic Rocks of the Isle of Man," collected on one of the longer excursions.

Papers on the **Drift deposits** in other districts appear frequently, e.g., "The drift sections of the Holderness "Coast, Yorkshire," by Mr. Hugh F. Hall, F.G.S., 1866-7; and "The Geology of the district of Creuddyn, "Llandudno," by the same author, 1867-8; "Notes on "Glacial Deposits and Markings in the South of the Isle "of Man," by Mr. W. Hewitt, B.Sc., 1887-8; "The Drift "beds and boulders of the Lowther and neighbouring hills "and valleys," by Mr. John Smith, 1899-1900. An interesting note by Mr. G. F. Deacon, M. Inst. C.E., on "The Glacial Geology of the Vyrnwy Valley," being observations made while constructing the great retaining dam for the Liverpool water scheme, is appended to a paper on "The Vyrnwy Valley," by Sir J. A. Picton in the Proceedings for Session 1888-9. A paper on "The Glacial Geology of Anglesey" (1904-5), by Mr. W. Edwards, F.G.S., gives a careful account of the drift deposits on the island and the scattered boulders, concluding that the *moutonnée* appearance of the rocks to the

North-East and the distribution and arrangement of the boulders, &c., strongly support the theory of land ice moving in a South-West direction. The important series of papers by Mr. T. Mellard Reade on the drift deposits of various districts have been referred to previously under the heading of "Glacial Deposits and Striæ."

A paper embodying observations "On the Phenomena "of Glacial action in Norway" was communicated by Mr. J. A. Picton in 1873-4. Papers on personal observations of Glacial phenomena in Switzerland by Mr. J. Lomas and Mr. E. Dickson have been previously mentioned.

The **early traces of man** in the form of flint implements, &c., and recent caves and cave deposits, have been dealt with in several papers, e.g., by the first President of the Society, Mr. H. Duckworth, F.G.S., in the third session (1861-2); "Flint implements from the drift; an account of "a visit to Amiens and Abbeville;" Mr. R. A. Eskrigge, F.G.S., 1879-80, "Notes on Human Skeletons and traces "of human workmanship found in a cave at Llandudno," with a note on the remains by Professor Boyd Dawkins, F.R.S.; also Mr F. Archer, B.A., in 1880-1, a paper "Notes on the worked flints of the Raised Beaches of the "North East Coast of Ireland." Mr. Morton in his Presidential Address, October, 1887, gave an account of the excavations at the Fynnon Beuno and Cae Gwyn Caves in North Wales, and the finding of a flint flake in the bone earth beneath the boulder clay at the latter cave while he was working there with Dr. H. Hicks, F.R.S. Mr. J. Lomas read a paper on "Some Flint Implements found in the "Glacial deposits of Cheshire and North Wales" 1898-9; and some explorations of recent caves in the Carboniferous Limestone have been dealt with in two papers by Mr. H. Brodrick, M.A., 1903-4 and 1904-5.

Mr. Charlton R. Hall in 1864 read a paper, embodying much research, entitled " Some Conjectural hints towards " determining the Ancient Coast Line of North Wales, " between the River Dee and the Island of Anglesea," and in the following session, 1865-6, Mr. H. F. Hall contributed a " Notice of Submerged Forests at Rhos, near " Colwyn." Mr. D. Mackintosh, F.G.S., in his Presidential Address in October, 1882, dealing with the changes in relative levels of land and sea along the West and South Coasts of England and Wales, summarised his observations on submerged forests and raised beaches at various points round the coast.

Chemistry in its relation to Geology has been the subject of a number of papers by members specially qualified to deal with such questions. Examples of these will be found in Mr. A. Norman Tate's papers on " The Origin " of Petroleum and other Natural Hydrocarbons," 1885-6, and " Iron as a Colouring Matter of Rocks," 1886-7; papers by Messrs. E. Dickson and P. Holland, on the " Sediments and Dissolved Matters in Glacial Streams," 1889-90, 1890-1; on " The Formation of Clay," 1892-3, and " The Chemical Composition of Triassic Sandstones " and Marls," 1895-6; and Mr. E. Dickson's Presidential Address on " Chemistry as an Aid to Geology," October, 1894. Chemical Analyses of various rocks, by Mr. P. Holland, working in association with Mr. T. Mellard Reade, appear in a number of papers, viz., " Ludlow " Rocks," 1906-7; " Longmyndian Rocks," 1907-8; " Phyllades of the Ardennes and Slates of North Wales and the Lake District," 1897-8, 1899-1900, and 1900-01. Dr. A. R. Dwerryhouse, F G.S., took as the subject of his Presidential Address, in October, 1908, " The action of " Carbon di-oxide in the Constitution and Decomposition " of Rocks, The two Presidential Addresses of Mr. C. C. Moore, F.I.C., October, 1901, and October, 1902, dealing at considerable length and in an original manner with the question of "The Volume Composition of Rocks," are important contributions to this department of geological science. In the first of these addresses, in which Mr. Moore dealt mainly with the theoretical considerations involved in his subject, he sought to show that "the "ordinary way of stating a chemical analysis of a rock "as percentages by weight may be absolutely useless for "the purpose of determining the real constitution of the "rock." In his second address he described in detail an important chemical and physical investigation of an intrusive sheet of dolorite, and the altered slate rocks above and below, occurring near Glyn Ceiriog.

The combined **Physical and Chemical** investigation of a large series of "Sands and Sediments" of various geological ages and collected from various parts of the globe by Mr. T. Mellard Reade and Mr. P. Holland working in conjunction, which is described in three papers in the Proceedings for Sessions 1903-4, 1904-5, and 1905-6, with a discussion of their bearings upon the origin and deposition of sediments, is worthy of very careful study, and forms a valuable contribution to Physical Geology.

Mr. Mellard Reade's important addresses on "Chemi-"cal Denudation in relation to Geological Time," October, 1876; "The Denudation of the Two Americas," October, 1884; and "The North Atlantic as a Geological "Basin," October, 1885, were afterwards incorporated in his published books and are worthy of much more than a passing mention. The same applies to the addresses by Dr. C. Ricketts on "Valleys, Deltas, Bays, and Estuaries," October, 1871, and "Fissures, Faults, Con-"tortions and Slaty Cleavage," October, 1872.

The description of the **recent deposits** formed on the bed of the Irish Sea, based upon an examination of the samples obtained in the course of the systematic dredgings carried out by the Liverpool Marine Biology Committee, will be found in papers by Professor W. A. Herdman, F.R.S., 1893-4, Mr. E. Dickson, 1893-4, and Professor Herdman and Mr. J. Lomas, 1897-8. Mr. T. Mellard Reade's paper on "The Geological Significance "of the Challenger Discoveries," Session 1877-8, should be mentioned. Attention should also here be directed to the papers by Mr. Dickson on the estuary of the Ribble, 1887-8 and 1893-4, in which he deals with the dissolved matter carried down by the river, the formation of sand and its accumulation in shifting banks, the gradual silting up and formation of new land behind the training walls, &c.

Biological questions in relation to Geology are discussed in the papers by Prof. Herdman on "The presence "of Calcareous Spicules in the Tunicata," 1884-5, and on "The Conservative Action of Animals in relation to "Dynamical Geology," 1884, as also in a paper by Mr. J. Lomas on "The occurrence of internal Calcareous "Spicules in Polyzoa," 1886-7. Special papers on some departments of **Palæontology**—in addition to those dealing specially with the Triassic footprints from Storeton (see page 38)—are found in the description of the Fossil Ferns collected by the Rev. H. H. Higgins, from the Coal Measures at Ravenhead, and described by Mr. F. P. Marrat, 1871-2, and "Some Fossil Plants from Doulton's "Delph, St. Helens," by Mr. J. Lomas, 1894-5. Mr. F. P. Marratt, in 1878-9, contributed a paper on "Recent and Fossil Nassa." Mr. Morton in his Presidential Address, October, 1886, on "Early Life on the Earth," gave a valuable summary of existing knowledge as to the time of the first appearance in the geological series of the various classes of plants and animals. Professor Herdman in his address as President, October 1899, on "The Geological succession "of Morphological Ideals," discussed the subject from the point of view of the most dominant forms of life in each successive period; following this up in the following session, 1900-01, with an address on "The Geological "Succession and Origin of Man." In the last published Proceedings, 1908-9, Mr. H. Broderick has a "Note on "some footprints recently discovered in the Inferior "oolite of Whitby.'

Petrology and Mineralogy have formed special subjects of study by several members, whose results have been laid before the Society from time to time. The microscopic and chemical examination of the Triassic rocks by Messrs. Morton, Reade, Lomas, Dickson and Holland, has been elsewhere referred to, as have also the papers on Slates and Slaty Cleavage, by Messrs. Ricketts, Reade, and Holland. Mr. W. Semmons contributed papers detailing results of examination of a collection of specimens of Chrysocolla from various localities, 1877-8; and also "Notes on the Mineralogical Structure of some "(8) Cornish Granites," 1877-8; while his address as President in October, 1879, dealt mainly with the structure and mode of origin of Granite Rocks. The basaltic dykes of Mull have been dealt with in papers by Mr. J. Lomas, 1888-9, and Mr. T. H. Cope, 1907-8. A paper by Mr. Lomas on "Quartz dykes near Foxdale, Isle of Man" appears in Session 1902-3. Mr. Lomas described experiments on the artificial production of Perlitic Structure, 1893-4, and a paper containing "A Theory to account for "the hexagonal forms of Basalt columns and other "structures," in 1894-5. Dr. C. Callaway, F.G.S., in Session 1895-6, following on an excursion of the Society to the Malvern district, read a paper entitled "A Sketch "of the process of Metamorphism in the Malvern "Crystallines."

Mr. T. H. Cope, F.G.S., has contributed in recent sessions several important papers containing the results of some careful investigations and studies on the structure, mode of occurrence, and history of certain volcanic rocks, e.g., "The igneous rocks of Aran Mowddy," 1896-7; "The Gabbro of Llyn Eigiau,"- 1898-9; also in his address as President in October, 1903, on "Types of "Rock-Flow in the Ceiriog Valley and their analogies "with River Structure."

Mr. Lomas in his addresses as President in Sessions 1897-8-9, discussed two interesting lithological problems: "Do the Crystalline Gneisses represent portions of the "Original Earth's Crust?" 1897-8, and "Is there a "lithological Homotaxis," 1898-9. Mr. T. Mellard Reade in his first address as President, October, 1875, took for his subject "The Moon and the Earth;" and in Session 1887-8 contributed some Geological and Physical notes as a supplement to a paper on "A Theory to "account for the airless and waterless condition of the "Moon," by Rev. F. F. Grensted, M.A. Mr. W. Hewitt in a Presidential Address, October, 1891, considerered "The Earth in its Cosmical Relations," and Dr. A. R. Dwerryhouse in a similar address, October, 1907, devoted his attention mainly to the Planetesimal hypothesis of the origin of the Solar system.

C.—BIOGRAPHICAL NOTICES OF SOME MEMBERS OF THE SOCIETY.

FRANCIS ARCHER, B.A.

Mr. "Frank" Archer was born in Liverpool in 1839, his father, Francis Archer, being a well-known surgeon in the town, who took a great interest in natural history subjects, being at one time President of the Liverpool Natural History Society. Mr. Frank Archer was educated at the Liverpool College, and afterwards at Trinity College, Cambridge, where he graduated as a wrangler in 1862. He was engaged in Liverpool for the greater part of his life as a solicitor, but for a time left that profession to engage in journalistic work. As a solicitor he acted professionally for several important railway, water, and other undertakings.

He became a member of the Liverpool Geological Society in November, 1866, and remained a member up to the time of his death in February, 1892. He acted as Hon. Treasurer for five sessions from 1867 to 1872. He is represented in the printed Proceedings by only one paper, "Notes on the Worked Flints of the Raised "Beaches of the North-East Coast of Ireland," but he made several other communications to the Society on Flint Implements from other localities, mainly the result of his own personal investigations and illustrated by exhibits from his extensive collection. He participated in several of the longer excursions, on which occasions his extensive and varied knowledge of natural history subjects, as also his genial disposition, added largely to the success of the expeditions.

ROBERT BOSTOCK.

One of the most active among the early members of the Society was Mr. Robert Bostock, a baker who had a shop in Birkenhead, but who managed along with his business to find time for much careful observation of the geological features of the district, and a good deal of reflection and thought on the meaning of the same. He was elected a member in October, 1862, at the beginning of the fourth session, and continued in membership until his death in the course of Session 27 (1885-6). Mr. Bostock constructed for himself a number of maps and sections, and made a beautiful copy by hand of the 6-inch ordnance map of the district on which to record his observations. He gradually got together a good collection of geological specimens. His first paper on "The "probable source of Holywell Spring," in Session 1867-8, was followed in the next session by a paper on "The New "Red Sandstone as a source of Water Supply," in which he maintained that much of the water taken from the local wells, especially on the Cheshire side of the Mersey, was derived by percolation from the sea. In a subsequent paper on "The Mersey and the Dee, their former channels "and changes of level," 1869-70, he strongly contests the theories that had been put forward as to the Mersey having in recent geological times found its way to the sea by other than its present channel. In 1880 he read a paper embodying his observations on the Keuper beds, illustrated with a map and sections, and deposited these with the Society for reference, in preference to their immediate publication.

In March, 1873, he read a paper, which was not printed, in which he contended that the circuitous route by which the Romans laid out their road from Chester, through Eccleston and Aldford, to their station at Caergwrle, and others in North Wales, was due to the former existence of a great extent of marsh land to the West of Chester.

He was recognised locally as an authority on the geology of the district, and in 1867 was employed by the Birkenhead Improvement Commissioners to make a series of trial borings 50 to 80 feet deep across the valley of the Fender near Upton, and to report on the same in connection with a proposed new well.

ROBERT A. ESKRIGGE, F.G.S.

Mr. Eskrigge joined the Society in its fourth session (Nov., 1862), and continued his membership for 30 years. In the earlier years of his membership he took an active part in the meetings and was elected President for the two Sessions 1867-8, 1868-9. He communicated several papers to the Society, some of them dealing with his observations on the beds in North Wales containing *Paradoxides Davidis*, new localities for which were discovered by the author. His last paper, in Session 1879-80 was on "Human Skeletons and traces of Human Workmanship "found in a Cave at Llandudno," in a cave on the S.E. face of the Great Orme and considered by Professor Boyd Dawkins to be of Neolithic age.

Mr. Eskrigge was in business in Liverpool as a cotton broker, was a Justice of the Peace for Cheshire, and for some years a member of the Wallasey Local Board. He died in November, 1898, at the age of 62.

JOHN J. FITZPATRICK.

Mr. J. J. Fitzpatrick, who was born in Westmeath, Ireland, was in partnership in Liverpool with his brother, Mr. Michael Fitzpatrick (also a member of the Society) as a coal merchant. He was elected a member in November, 1875, and so continued until his death in October, 1903, He was a regular attendant at the meetings and took part in the discussions. He acted as Hon. Librarian for seven sessions (1889-1896). He contributed several papers to the Proceedings, e.g., "The "Permian Conglomerate and other Palæozoic rocks to "the North of Morecambe Bay" (1888-9); "The Permian "Conglomerate of the Vale of Eden" (1893-4); "Recent "Discovery of a Bone Cave at Deep Dale, near Buxton" (1889-90, and 1891-2). A photograph of Mr. Fitzpatrick appears in the Proceedings for Session, 1903-4. Mr. Fitzpatrick was an active member of the Liverpool Naturalists' Field Club, and did much to create an interest in Geology by directing attention to the geological features of the districts visited by the Club. He wrote the article on "The "Geology of the Liverpool District" for the volume on "The Flora of the Liverpool District" published by the Club in 1902.

REV. HENRY H. HIGGINS, B.A.

For a number of years the Rev. H. H. Higgins was one of the best known figures among the scientific workers of the City, an active member of several of the scientific societies, and the founder and President of the Liverpool Naturalists' Field Club, which was established in 1860.

He was born at Turvey Abbey in Bedfordshire in 1815, and educated at Corpus Christi College, Cambridge, where he graduated in 1836. He came to Liverpool in 1842 as Inspector of Church of England Schools, and was Chaplain to the County Asylum at Rainhill from 1853 to 1886. For many years he served as a co-opted member of the Library, Museum and Arts Committee of the Corporation, acting as the Chairman of the Museums

Committee and taking an active personal part in the arrangement of the Museums Collection, especially of the invertebrates. In 1876 he visited the West Indies and subsequently published a book entitled "Notes by a "Field Naturalist in the Western Tropics."

He became a member of the Liverpool Geological Society at the end of its first session in October, 1860, and continued as a member to the time of his death in 1893. He took an active part in the earlier meetings of the Society. While living at Rainhill he took advantage of an exposure of the coal measures in a railway cutting at Ravenhead, near St. Helens, visiting the place twice a week for a period of ten months. He made an extensive collection of fossil plants from these beds, which were described before the Society at its meeting on March 12, 1872, the paper being printed with a number of lithographed plates in the Proceedings for Session 1871-2. The Ravenhead Collection is now in the Liverpool Free Public Museum.

JOSEPH LOMAS, A.R.C.S., F.G.S.

Mr. Lomas was born in 1860 at Bugsworth, in Derbyshire and was for some time engaged in teaching, entering the Royal College of Science, South Kensington, as a student in 1880. Along with other subjects he took Geology, passing through the practical laboratory and field course then recently organised by Professor Judd. He obtained the Associateship diploma of the College in the divisions of Biology and Geology. In 1884 he was appointed Assistant Science Demonstrator under the Liverpool School Board, and in 1892 he became Chief Science Demonstrator, having charge of the experimental science teaching in the various elementary schools.

JOSEPH LOMAS, A.R.C.S., F.G.S.

He was elected a member of the Liverpool Geological Society in November, 1885, and soon began to take an active part in its work. He served as President for the Sessions 1896-7 and 1897-8, and was again elected President in October, 1908, with a view to his occupying that position in the Society's Jubilee year. On December 11, 1908, Mr. Lomas left Liverpool to proceed to Biskra, in Algeria, on an investigation in connection with a Committee of the British Association; and while on his outward journey he met with his death on December 16, in a railway accident at El Achir. The wide-spread expressions of regret which followed the announcement of the sad news showed that Mr. Lomas had won by his scientific work a considerable reputation as a geologist, and had already entered upon a wider sphere of usefulness and promise in connection with the science. His work for the Society during the last years of his life was invaluable, his enthusiasm and genial personality contributing largely to the success of both indoor and outdoor meetings.

Shortly after coming to Liverpool Mr. Lomas took up research work in the Zoological department of University College (now the University of Liverpool) under Professor Herdman, D.Sc., F.R.S., &c., and gave special attention to the study of Marine Polyzoa, mainly in connection with the material collected by the Liverpool Marine Biology Committee in their dredgings in the Irish Sea. Mr. Lomas wrote the section on Polyzoa in the First Report, published by that Committee in 1886, on the Fauna of Liverpool Bay and the neighbouring seas. His first paper before the Society (December, 1886) on "The "Occurrence of Calcareous Spicules in Polyzoa" arose out of these studies. At a later date (Session 1897-8) in collaboration with Professor Herdman he submitted a valuable Report to the Society on "The Floor Deposits of "the Irish Sea." In 1886 he became Special Lecturer on

Geology at University College and he continued in this capacity to give evening and Saturday morning courses of lectures up to the time of his death. In connection with these lectures he succeeded in getting together a useful teaching collection of specimens, models, maps, &c. As a lecturer and a practical worker he was very successful in enlisting the sympathetic interest and assistance of a number of students, several of whom have since become active and distinguished workers in Geology.

From 1903 Mr. Lomas acted as Secretary of the Committee appointed by the British Association to investigate the Fauna and Flora of the Trias, in the work of which Committee another member of the Society (Mr. H. C. Beasley, F.G.S.) also took a prominent part. Mr. Lomas devoted a good deal of attention in the later years of his membership to the probable conditions under which the Triassic rocks were formed, and after his visit to South Africa with the British Association, in 1905, he read an important paper (October, 1906) on "Desert "Conditions and the Origin of the British Trias." At the meeting of the British Association in Dublin in 1908 (where he served as Recorder for Section C) a special Committee was appointed with Mr. Lomas as Secretary "to investigate the ancient salt lakes and other desert "phenomena at Biskra, Algeria, in particular relation to "the British Trias," and it was in this connection that he undertook his last journey.

In addition to his interest in the subject of the Triassic rocks, Mr. Lomas was well known as an enthusiastic Glacialist. His first paper on Glacial Geology was read before the Society in February, 1887, and for some years he was a prominent advocate of the land-ice theory of the origin of glacial deposits. He was the chief worker on the Boulder Committee appointed by the Society in 1889, and presented detailed reports of his examination as to the boulders and markings on the shores of the Mersey When the Glacialists' Association was formed in 1891, he became an active member and for some time acted (along with his friend Professor P. F. Kendall, F.G.S.) as one of the editors of the Glacialists' Magazine. He made several excursions to Switzerland as the leader of small parties consisting of members of Societies with which he was connected, to study the action of existing glaciers, and the results of these investigations are given in two papers on the subject contained in the Proceedings of the Society for 1895-6 and 1898-9. An excursion to the Faröe Islands was undertaken largely with a similar object in view, and a paper on "The Geology of the Faröe "Islands" was laid before the Society in February, 1895.

Mr. Lomas was a good petrologist and had also a good working knowledge of palæontology. He constructed some excellent topographical models of the district around Liverpool, one of which he coloured geologically and exhibited at a meeting of the Society. Many of the Field Meetings of the Society in recent years were under his leadership, and his familiar knowledge of the districts and skill in directing attention to the chief points of interest, as well as his personal good nature, were much appreciated by his colleagues.

He was elected a member of the Geological Society of London in 1897, in which year he was awarded by that Society the balance of the proceeds of the Lyell Fund. From 1899 he acted as one of the Secretaries of the Geological Section of the British Association, and was a regular attendant at its meetings and contributor to its Proceedings.

A list of Scientific papers (74) by Mr. Lomas is contained in the Proceedings of the Society for Session 50.

DANIEL MACKINTOSH, F.G.S.

Mr. Mackintosh was born at Blairgowrie, in Perthshire, in 1815. He was engaged for some time in giving lectures on Science at schools and public institutions on Astronomy, Geology, Physical Geography, &c., at first in the South of England and then in the Midlands and North Western Counties. He made use of the opportunities afforded him in his journeys to study the physical geography and geology of various districts, and in 1869 published a book on "The Scenery of England and Wales." He became a member of the Geological Society of London in 1861, and communicated papers both to that Society and to the British Association.

About 1871 he removed to Chester and shortly afterwards to Birkenhead. He became a member of the Liverpool Geological Society in the Session 1877-8, and continued as an ordinary member until November, 1886, when he was elected an Honorary Member, and so remained until his death in July, 1891. He was President of the Society in the Sessions 1881-2 and 1882-3; his Presidential Address being on the first occasion on "The "Post-Tertiary changes of level round the coast of "England and Wales," and the second on "The Time "which has elapsed since the Close of the Glacial Period." Mr. Mackintosh communicated two other papers to the Proceedings of the Society, both on subjects connected with Glacial Geology. His descriptions of the High Level Shelly Drifts of Moel Tryfaen, Minera Mountain, &c., and his "Systematic Survey in 1878 of the direction and "limits of dispersion of the boulders of the West of "England and the East of Wales," both published in the Quarterly Journal of the Geological Society, attracted attention for their accurate and detailed descriptions of the facts. For his work in Glacial Geology he was, in

1886, awarded by the Geological Society of London the balance of the proceeds of the Lyell Fund.

FREDERICK P. MARRAT.

Mr. F. P. Marratt was one of the nine original members of the Society and took an active part in its work, especially in the early years of its existence. He was born at Boston, Lincolnshire, in 1820, and died in Liverpool November 5th, 1904. At one time he kept a shop for the sale of minerals, fossils and other natural history specimens in "the Arcade," Liverpool. For a long period he occupied the position of conchologist at the Liverpool Free Public Museum, and he had an important private collection of shells and minerals. He identified the ferns collected by the Rev. H. H. Higgins at Ravenhead, and described them in an illustrated paper before the Society on March 12, 1872, "On some Fossil "Ferns in the Ravenhead Collection." In Session 20 (1878-9) he read a paper on "Recent and Fossil Nassa," in which he showed the wonderful amount of variation of this shell, illustrated by a large series of specimens from his own collection. He had an extensive and detailed knowledge of minerals and shells.

THOMAS J. MOORE, C.M.Z.S.L.

Mr. T. J. Moore was one of the original members of the Society and continued a member to his death in 1893. He was born in London in 1824, his father being employed in connection with the Royal Zoological Society, with which body Mr. Moore himself was also for a short time employed. In 1843 he became Curator of the Natural History Collection of the Earl of Derby at Knowsley, and when that collection was handed over by its noble owner to the Corporation of Liverpool, Mr. Moore became

Curator of the Free Public Museum in which it was housed. His communications to the Society were mainly concerned with specimens in the Derby Collection, and the records of the Society show that he frequently exhibited and briefly described specimens of various kinds, including specimens of animal remains found in the post-glacial deposits of the neighbourhood. He died on October 31, 1893.

GEORGE H. MORTON, F.G.S., F.R.G.S.I.

Mr Morton was the real founder of the Society and for many years its chief moving spirit. The meeting at which the Society was constituted, as well as the first three general meetings, were held at his house, 7, London Road. He acted as Secretary from the date of the first general meeting in January, 1860, until the end of the ninth session in October, 1868, when he temporarily relinquished the office on his election as President for the tenth and eleventh sessions (1868-1870). He then resumed the secretaryship and served the Society in that capacity for a further period of 15 years (making a total service as Secretary of 24 years) until his election for the second time to the Presidential Chair in October, 1885. He continued an active working member of the Society to the time of his death on March 26th, 1900, and is represented in the Proceedings by a total of 61 papers.

In 1887, at the close of Mr. Morton's second term of office as President, he was presented with an address and testimonial subscribed for by past and present members of the Society.

Mr. Morton was born in Liverpool in July 9th, 1826, and was educated at the Liverpool Mechanics' Institute. He states that in his school days he was interested "in "the living things in ponds and in the succession of the

(*Photo. by Maull & Fox.*)

GEORGE H. MORTON, F.G.S.

"strata as given in a school reading book of the time." Later still the stratification exhibited in a quarry in Shaw Street attracted his attention and set him enquiring, and shortly afterwards he "purchased Knight's 'Store of "'Knowledge' because there was an article in it entitled "'The Mineral Kingdom.'" In a MS. Autobiographical Sketch (extracts from which the writer is permitted to give) he says "Before I obtained that book there did not "seem anything worth my attention, although time hung "heavily on my hands; but as soon as I began to read the "pages on the Geological History of the Earth, a change "came over me, for I had found a subject of engrossing "interest—something worth living for." He began to collect minerals, fossils, and shells, which he was able to name by reference to the collections which were then exhibited in the Royal Institution, Colquitt Street.

After a short membership of several local scientific and literary societies, which were formed among the younger men of the town and lasted only for very short periods, he appears to have been introduced to organised scientific work as a member of the British Association which met in Liverpool in 1854. In the following year he joined the Liverpool Literary and Philosophical Society, to which in January, 1856, he communicated his first important scientific paper on "The Sub-divisions of "the New Red Sandstone between the River Dee and the "rise of the Coal Measures East of Liverpool." He communicated several other papers of geological interest to the same Society; but after the establishment of the Liverpool Geological Society most of his geological work was laid before the meetings of that Society and printed in its published "Proceedings." This work was done as an enthusiastic amateur Geologist, while he was at the same time carrying on a successful business in Liverpool as a house painter and decorator.

In 1864 Mr. Morton was appointed Lecturer in Geology in the evening classes of the Queen's College, an institution established by the Directors of the Liverpool Institute, in connection with the London University; and classes in Geology under Mr. Morton appeared regularly in the prospectus of Queen's College until the session 1874-5, though it would appear that a very small number of persons attended the classes.

In 1861 Mr. Morton gave a lecture before the Liverpool Naturalists' Field Club "On the Geology of the "Country around Liverpool," which was separately published by the Club in a somewhat enlarged form in 1863. In 1891 he brought out a much enlarged second edition of this book embodying the results of work during the intervening 27 years, and in 1897 he added an Appendix containing an account of the most important additions to the knowledge of the local geology during the preceding six years, with a coloured geological map of the district. This volume forms the standard handbook, invaluable to all local workers and the starting point for all subsequent investigations.

In addition to his work in the Triassic and Glacial beds in the immediate neighbourhood of Liverpool, Mr. Morton devoted a large amount of time to the personal study of the Carboniferous Limestone of North Wales, and the other beds in the same district lying between the Limestone and the Coal Measures to which he gave the general name of the Cefn-y-fedw Sandstone. The series of papers begins in 1875-6 with a paper on the Llangollen district, followed by papers on the Carboniferous Limestone of Flintshire, and the Vale of Clwyd, ending with a posthumous paper on the Carboniferous Limestone of Anglesey, in 1900-1. The examination of these beds in detail over a large area, including their physical structure, distribution, dislocations and fossil remains, occupied Mr. Morton's attention for many years, during which all the time that he could spare from his business was spent in the particular district which, for the time being, was the special object of his study.

In 1899 he completed the record of his observations, carried out for so many years, on the disposition of the various sub-divisions of the Trias in the area of Liverpool, and the numerous faults which had from time to time been exposed. These observations were marked on a copy of the 6-inch ordnance map, which he then presented to the Liverpool Free Public Library, and a copy to the Liverpool Geological Society. He devoted a great deal of time to the examination and description of the structure of the local Triassic rocks with a view to making use, if possible, of the structural differences for the determination of the horizon of the beds met with in different localities.

The first paper which appears in the printed Proceedings immediately after the abstract of the President's inaugural address, was a paper by Mr. Morton, read at the first meeting (Jan. 15, 1860), on "The Basement bed "of the Keuper formation in Wirral and the South-West "of Lancashire" As the result of his prolonged study of the character and distribution of the Triassic rocks Mr. Morton became the chief authority in the district on questions of applied Geology, and his advice was frequently sought in connection with water supply, boring or sinking for coal, &c.

Shortly before the establishment of the Liverpool Geological Society, Mr. Morton announced to the Literary and Philosophical Society the discovery of scratched rocks in the neighbourhood of Toxteth Park, and on February 11, 1862, he read a paper before the Liverpool Geological Society (entitled "On the Surface Markings near "Liverpool supposed to have been caused by ice") on this exposure and on two other localities which he had discovered in the brickfields in Kirkdale—all these localities have long since been built over. In 1870 he gave a general resumé of the observed phenomena in a paper entitled "Glaciated Condition of the Surface of the "Triassic Rocks around Liverpool," and in March, 1887, he submitted to the Society a tabulated list of all the recorded striæ in the area, extending as far as Manchester and Blackburn. This is practically his last communication on Glacial Geology, with the exception of a brief reference in his last Presidential Address in October, 1887; but the subject is dealt with in detail in the second edition of his book.

He was elected a Fellow of the Geological Society of London in 1858, and in 1892 was awarded the Lyell Medal. Sir Archibald Geikie, the President, in presenting the Medal said that it had been given "in recognition of "your long and meritorious services to Geology in the "work which you have done around Liverpool. To you "we are largely indebted for the extent of our knowledge "of the Triassic and other strata of that district. Your "full and accurate account of the Glacial phenomena of "your neighbourhood forms an especially important part "of your labours."

A most useful service which Mr. Morton rendered to local geology was his compilation of a list of all the published papers and works referring to the geology of the district, which he communicated to the Society and which was published in the Proceedings as follows:—(1) in his two Presidential Addresses in 1869 and 1870; (2) in 1881, papers and works from 1870 to June 1881; and (3) in 1891, works and papers from June, 1881, to September, 1890.

SIR JAMES A. PICTON, F.S.A.

Mr. J. A. Picton was born in Liverpool in December, 1805, and was educated at several private schools, which he left, however, before the age of 14 to assist his father in his timber yard and afterwards as a surveyor. He worked hard for some years in the face of considerable difficulties due to his father's financial embarrassments. In 1826 he entered the office of Mr. D. Stewart, a surveyor, and ultimately became a partner and then successor to the business, in connection with which he developed an architectural side and was responsible for the designs for a number of public buildings in Liverpool. His own prolonged studies under difficulties made him sympathetic with the similar struggles of others, which showed itself in the interest he took in the establishment of the Mechanics' Institute, and afterwards as the moving spirit for many years in the establishment of the Public Library. He was a member of the Town Council from 1849 to the time of his death in July, 1889, and for many years was Chairman of the Library and Museums Committee. He is best known for his work on the "Memorials of "Liverpool" (Vol. I, Historical; Vol. II, Topographical) published in 1873. He was knighted in 1881.

Mr. Picton was elected a member of the Society at its third meeting, and continued a member up to the thirtieth session (1888-9) when he died. His first paper was given in Session 1872-3, "Notes on the Phenomena of "Glacial Action in Norway," in which he described at some length the results of his observations in that country after a study for several years of the signs of glacial action in Wales. In Session 1888-9 he contributed a paper on "The Local Historical Changes in the surface "of the land in and about Liverpool," supplementing largely from personal recollections a previous paper by

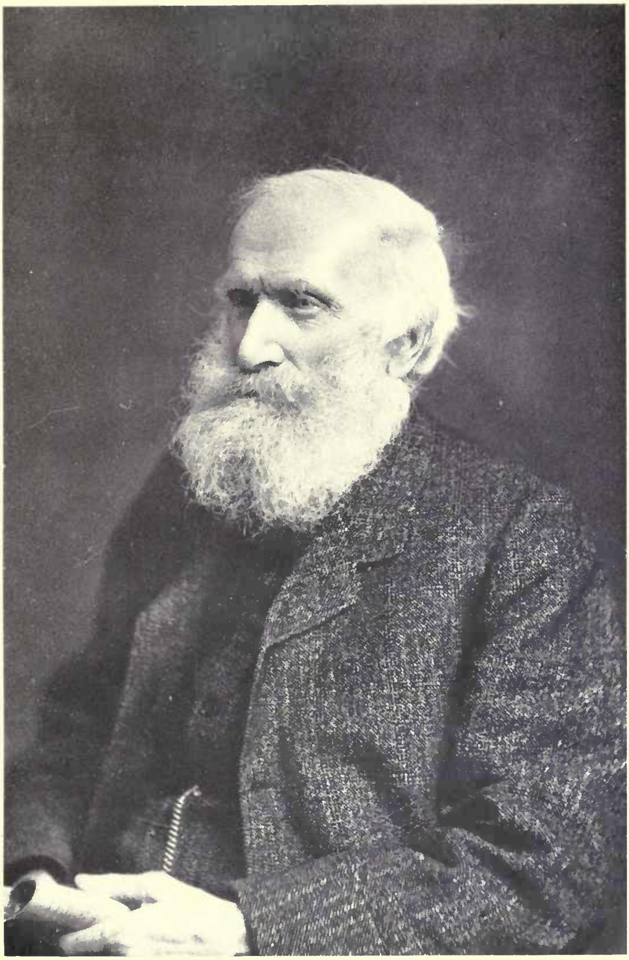
Mr. Morton on the same subject. In the same session he read a paper on "The Vyrnwy Valley, its Geological and "Glacial History" which was accompanied by a valuable supplementary "Note on the Glacial Geology of the "Vyrnwy Valley," by Mr. G. F. Deacon, M. Inst. C.E., the eminent engineer who carried out the Liverpool Water Supply Scheme in that district.

CHARLES POTTER.

Mr. Potter was an officer in H.M. Customs for a period of over 40 years, and before coming to Liverpool had resided at Lewes in Sussex and at Hull. He was elected a member of the Society in the sixth session, November, 1864, and continued a member for 34 sessions until his death in December, 1898, at the age of 73. Mr. Potter is represented by only one paper in the printed Proceedings, viz., "Observations on the Cheshire Coast" (1868-9). Two or three other papers on the same subject were read before the Society but not published. Mr. Potter paid great attention to the post-glacial beds exposed on the northern shore of Wirral, and had a large collection of antiquities and remains found on the shore and derived from these beds. He adopted the theory of the drifted origin of the submerged "forest beds," and opposed the theory of the trees having grown *in situ* with some warmth and a certain amount of acerbity, which unfortunately gave rise to somewhat strained relations with prominent members of the Society, and stood in the way of his rendering to the Society such useful service as he might otherwise have done.

THOMAS MELLARD READE, F.G.S.,C.E.,F.R.I.B.A.

Mr. Mellard Reade was born in Liverpool in May, 1832. He received his education in private schools, but in 1834,



T. MELLARD READE, C.E., F.G.S.

before he was 13 years of age, he entered the office of a Liverpool firm of Architects and Surveyors. With the exception of about seven years spent in the Civil Engineering Department of the London and North Western Railway, at Warrington, the whole of his professional life was spent in Liverpool. It was in the course of his professional work that he was first led to take an interest in geological questions; but having once taken up the subject he gave it a whole-hearted devotion and it proved to him to the end of his life a source of great intellectual pleasure and enjoyment. He brought to bear upon the problems of the science a mind which was trained not only to observe and reflect, but also to measure and calculate; and his constant endeavour was to submit theories and conclusions whenever possible to a quantitative test in the light of known laws of physics and mechanics. He died May 26, 1909, at the age of 77 years.

Mr. Reade was elected a member of the Society in December, 1870, and in November, 1871, he submitted the first, and one of the most important, of a long series of papers. This was on "The Geology and Physics of the Post-"Glacial Period as shewn in the deposits and organic "remains in Lancashire and Cheshire," which is printed at length in the Proceedings, accompanied by a map and series of sections printed in colours. In it he says "My "attention was first drawn to the subject of Post Glacial "Geology by the discovery of marine shells in the "excavations of the Birkdale main outlet sewer, and an "attempt to discover under what conditions these beds "were laid down led me very rapidly into the consideration "of the subject as a whole." The paper is a good example of the orderly and logical way in which, in his papers generally, he first arranges his data and sets out the facts, following this by a separate statement of "general deduc-"tions" or "summary of conclusions." To the subject of

Post Glacial Geology he continued to give attention to the last, losing no opportunity of examining fresh sections and of recording the same. In a paper on "The Formby "and Leasowe Marine Beds as shown in a Section near "Freshfield" (Session 1875-6), he says in reference to these local post glacial deposits "I have presented to the "Liverpool Museum a complete series of specimens and "have arranged them in a way to be readily understood "by the aid of my original paper on the subject." The last but one of the 70 papers which Mr. Reade communicated to the Society and which were published in the Proceedings, was on these same deposits: "Post-"Glacial Beds at Great Crosby," December 10, 1907.

Arising out of his study of these Post Glacial beds Mr. Reade was led to infer the existence of an old buried Pre-Glacial Valley of the Mersey, the evidence for which he set forth in a paper read before the Society on January 14, 1873. After describing the data which he had collected from borings, dock excavations, &c., and his inference that a deep rock channel filled with drift existed in the present bed of the river between Liverpool and Birkenhead, he added "The subject is surrounded with difficulties, "the data is insufficient to warrant absolute conclusions, "we must therefore wait." The sequel is found in his paper read before the Society twelve years later (Jan. 13, 1885), on "The Mersey Tunnel, its geological aspects "and results" in which he speaks of the pleasurable emotions with which he had recently seen in the tunnel works the bottom of the old pre-glacial valley exposed for about 100 yards in the roof of the tunnel.

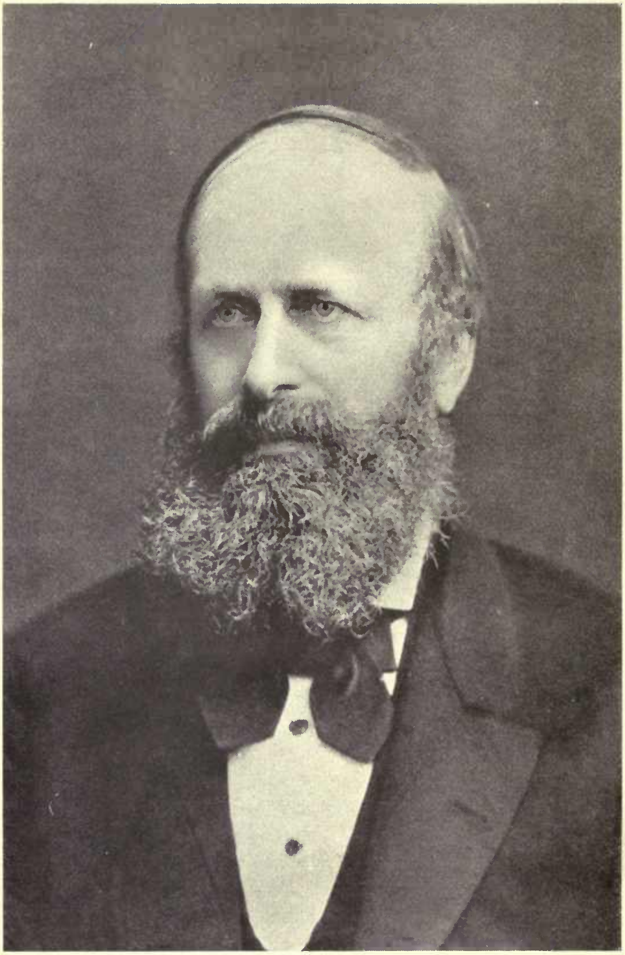
Mr. Reade also made a special study of the Glacial beds of the district, and reference to the published Proceedings will show how persistently he followed this up, with a careful study and description of beds of the same age in various parts of the country, bringing the results of his work (undertaken mostly on long holiday excursions) from time to time before the Society, e.g., in the areas of the Clyde and Forth (1879-80), South of England (1880-1), Yorkshire (1882-3), Moel Tryfaen (1892-3), Dublin and Wicklow (1893-4), Ayrshire (1896-7), &c. Mr. Reade contended strongly for the marine origin of the low level boulder clays of Lancashire and Cheshire, and stoutly contested the position of the extreme land Glacialists; though he was careful to distinguish between the low level boulder clays and the drifts of the hill districts. In his sixth (and last) Presidential Address, on October, 1896, on "The present Aspects of Glacial Geology" he gave a valuable resumé of the results of his study of glacial problems. Several of his published papers deal with specially interesting boulders of large size, which he examined *in situ* in the boulder clay. One of these weighing about 18 tons (described in his paper on "The "Gypsum Boulder of Great Crosby"), found in a local brickfield, was by his influence carefully raised from the excavation and placed by the Urban District Council in position in a public place protected by an iron railing. The paper is illustrated by photographs, one of which, taken on the occasion of a visit by members of the Society, shows the boulder *in situ* in its original position with Mr. Reade standing on the top of it.

For many years Mr. Reade regularly took part in the longer excursions and contributed largely to their success both by his knowledge and his unfailing good humour. His habit of making careful notes and sketches of interesting facts upon the spot, and the regular practice of writing out these at length in a permanent form, illustrated with pen and ink sketches, at the close of each day's work, was an example and a stimulus to the younger members of the party. An interesting paper "Notes on the "Scenery and Geology of Ireland" in the Proceedings for

Session 1878-9 is illustrated by a number of lithographs of similar pen and ink sketches.

On three separate occasions Mr. Reade served as President, viz., in 1874-6, 1883-5 and 1894-6. In his second Presidential Address (Oct. 10, 1876) he took as his subject "Chemical Denudation in relation to Geological "Time," in which he attempts to find in the removal of matter in solution from the exposed land surfaces a geological modulus of time. To this subject he frequently returned, and as a special case he treated in his Presidential Address in October, 1884, on "The Denudation of the "Two Americas," with its sequel in the following year "The North Atlantic as a Geological Basin."

Before his third term as President Mr. Reade had taken up the systematic study of the movements of the earth's crust involved in the production of its larger surface features, the results of which studies he gave in his published book on "The Origin of Mountain Ranges, "considered experimentally, structurally, dynamically, "and in relation to their Geological history," (1886). In this book he announced his discovery of the existence in the crust of a contracting globe of a "level of no "strain." The problems of dynamical Geology had henceforward a great attraction for him, and his subsequent work was in large part devoted to such questions; and, auxiliary to the views enunciated in this volume, "British Geology "in relation to Earth Folding and Faulting" formed the subject of his fifth Presidential Address in October, 1895. Papers on "Slickensides and Normal Faults" (Session 1888-9); "Slate Structure and Slaty Cleavage" (1900-1), dealt with these dynamical problems. In 1903 he published his second book on "The Evolution of Earth "Structure, with a theory of Geomorphic Changes," in which he carried the subject still further and recorded the results of a number of interesting experiments.



Dr. C. RICKETTS, F.G.S.

Brief mention only can be made of Mr. Reade's contributions to the study of the Triassic rocks (which have been referred to in an earlier section) and his work on the microscopic characters of sands and sediments; some valuable papers on a careful investigation into the latter subject, in conjunction with Mr. P. Holland, F.I.C., being laid before the Society in Sessions 1903-4, 1904-5, and 1905-6.

Mr. Reade was elected a member of the London Geological Society in 1872, and in 1876 was awarded the Lyell Medal "in recognition of his work on the Origin of "Mountain Ranges, containing the records of much "original and experimental research."

CHARLES RICKETTS, M.D., F.G.S.

Dr. Ricketts was for many years one of the most regular attendants at the ordinary meetings and field meetings of the Society, being rarely absent on any occasion. He was very well known in the district in which he lived as a constant visitor to every excavation which was likely to afford any matter of geological interest. He was born at Titchfield, in Hampshire, in 1818, was educated at Bath, and took his degree of M.D. at Aberdeen in 1861. After spending a short time in North Lancashire he settled down in Birkenhead, where he practised as a medical man for a period of about 40 years. He gradually, however, retired from practice on account of advancing years, and in 1900 returned to his native county, where he died, at Curdridge, on February 29, 1904, at the age of 86.

He became a member of the Society at the beginning of the fifth Session (Nov., 1863), and in the following session was elected on the Council, on which he continued to serve for many years. He continued in full membership for 37 years and his work is represented by a total of 27 papers contained in the Proceedings. When leaving the district in 1900, he was elected an Honorary Member in recognition of his long and valued services. His unassuming yet independent character, his readiness to assist any one in connection with his favourite science at any cost of personal inconvenience, and his absolute sincerity, rendered him a general favourite.

His first paper before the Society was read on October 10, 1865, "On a wooden implement found in Bidston "Moss," which appears in abstract in the printed Proceedings with a footnote "This paper caused considerable "discussion and several members expressed their dis-"approval of the opinions expressed in it." It is not clear whether the diversity of opinion was upon Dr. Ricketts' description of the implement, or upon the theory which he here first enunciated, and which he afterwards constantly maintained, that the subsidence frequently observed at the mouths of large rivers is directly due to the weight of the sediment there accumulated. "Depression may *permit* "but cannot *cause* accumulation," he remarks in one paper. This theory, which, in its general principle, has since obtained considerable recognition, was original with Dr. Ricketts (though he afterwards found that Sir John Herschel had, in 1862, expressed similar opinions) and was developed more fully in his first address as President of the Society in 1871-2, on "Valleys, Deltas, Bays, and Estuaries." As connected with this subject he was led to attribute considerable importance, in the geological series, to the deposits formed in the estuaries of large rivers, e.g., in his paper "Remarks on the Upper Silurian Formation" (Session 1867-8); and in an interesting paper "Remarks on the Country around the Wrekin," 1875-6.

The Upper Silurian and Lower Carboniferous beds received a good deal of attention from Dr. Ricketts, especially the junction beds, as also the occurrence of signs of land surfaces in the limestone. He contributed several papers on these rocks, e.g., on the Ingleborough district (1868-9), Skipton and North Derbyshire (1879-80), "The "Base of the Carboniferous Limestone" (1886-7) and "On "some conditions existing during the formation of the "older Carboniferous Rocks" (1892-3). To some of these localities he led the Society on some of the longer field excursions.

His second Presidential Address in October was on "Fissures, Faults, Contortions and Slaty Cleavage" and in this he puts forward an original theory to account for earthquake shocks, as being in many cases due to the impact of wedge shaped masses of rock breaking away from the sides of faults into the fissure.

He was again elected President for the Session 1890-1, and took as the subject of his address on October, 1891, "Some phenomena which occurred during the glacial "epoch." Dr. Ricketts had paid considerable and minute attention for a long time to the erratics and other glacial phenomena occurring in the Birkenhead district, and brought his observations frequently before the Society. He called attention on several occasions to specimens which he had obtained (and exhibited) of boulders showing signs of weathering, which he considered had taken place while the stones were exposed in moraines before they were embedded in the clay; while in other cases he brought specimens of boulders which were split through but were found usually with the fragments in apposition. These he described in two papers containing the results of a great deal of careful observation, "Some remarkable pebbles in "the Boulder Clay" (Nov., 1878) and "On Split and "other boulders" (Nov., 1880). In his paper (Session 1874-5) on "The Cause of the Glacial Period, with "reference to Great Britain," he speculates upon the results which would follow from the possible submergence of the isthmus of Panama and the consequent deflection of the Gulf Stream.

The folding and contortion of rocks attracted his attention and is dealt with to a certain extent in several of his papers. In 1889 he constructed several ingenious models consisting of several layers of different coloured clays, which by the pressure of a superincumbent mass of sand (artificially augmented) were contorted and folded, and afterwards sectionised when dry. These models he described in the *Geological Magazine* for April, 1889, in a paper on "Physical Changes in the Earth's Crust." He connected this action with the loading of the layers of sedimentary deposit laid down in estuaries.

He made a careful examination of the sections of Coal Measures and Triassic beds exposed during the construction of the Huyton, Prescot and St. Helens Branch Railway, and submitted the results in a paper read before the Society in March, 1870. In connection with the meeting of the British Association in Liverpool of that year, at which he read a paper on the same beds, he conducted an excursion over the section. He was a very regular attendant at the meetings of the British Association.

He was elected F.G.S. in 1867 and at least one paper (on Glacial Geology) of his was published in the Quarterly Journal.

ISAAC ROBERTS, F.R.S., F.G.S., F.R.A.S.

Isaac Roberts was born at Groes, Denbighshire, in 1829; his school education was received in an elementary school, which he left to become an apprentice at the age of 14. He carried on his subsequent self-education under difficulties, and attended evening classes at the Liverpool

Mechanics' Institute. He subsequently built up a successful business in Liverpool as a contractor.

He was elected a member of the Society at the commencement of its fourth session, in November, 1862; and for a number of years he was a regular attendant at the meetings and took an active part in the discussions. His first paper was read on March 16, 1869 on "The Wells and "Water of Liverpool" in which he described the result of experiments which he had made on the passage of water through sandstone at various pressures, the amount of porosity of the rock, and observations on the character and probable source of the water in several wells which he had either sunk or deepened. He devised ingenious mechanical arrangements for observing and continuously recording the movements of underground waters, as affected by capillarity, rainfall, atmospheric pressure and other causes. He read two other papers before the Society on similar subjects at a later date, and he also took a prominent part in the discussions on the mode of formation of the submarine forest beds at Leasowe. He served as President of the Society in Sessions 1873-4 and 1874-5. His first Presidential Address was on "Volcanoes and "Volcanic Agency," describing observations during a recent personal visit to Vesuvius. His second address dealt with the Glacial Deposits, and in connection with it Mr. Roberts showed exhibits illustrating the results of a mechanical analysis of the boulder clay. His membership was discontinued after Session 1889-90, and in 1897 he removed to the South of England where he established an observatory on the summit of Crowborough Hill, in Sussex, and where he died 17 July, 1904.

In the later years of his life he was best known for his astronomical work and especially for his photographs of the stars and nebulæ, including the famous photograph of the nebula in Andromeda.

He was elected F.G.S. in 1870, and F.R.S. in 1890. By his will he made valuable bequests to the three Universities of Liverpool, North Wales, and South Wales, for the founding of scholarships to assist students of the Natural Sciences.

A. NORMAN TATE, F.C.S., F.I.C.

Mr. Norman Tate was born in Wells, Somersetshire, in 1837, and educated at the Chapter Grammar School of that town. He entered Dr. Sheridan Muspratt's chemical laboratory and there studied practical chemistry and chemical analysis, afterwards taking a position in the laboratory of a chemical works in Widnes. After this he set up in business in Liverpool as an Analytical Chemist, and having given special attention to the study of petroleum he published a useful hand-book on "Petroleum and "its Products." (In Session 1885-6 he read before the Society a paper on "The Origin of Petroleum and other "Natural Hydrocarbons.") Relinquishing for a time his practice as an analytical chemist he superintended the working of an oil refinery and acted as consulting chemist, but soon returned again to business in Liverpool and built up a very successful position as commercial analyst.

In 1870 Mr. Tate was induced to give instruction in chemistry in evening classes for members of trade societies, and shortly afterwards became Honorary Principal of the "Liverpool Science and Art Classes," an organisation for the conduct of evening classes in Science and Art subjects in connection with the Science and Art Department. To this work he devoted a great deal of time and money and was looked upon as one of the pioneers of technical instruction in the district. In 1888 he started a scientific periodical "Research," which after an existence of two years was discontinued. He died in July, 1892.

Mr. Tate was a member of the Society from Session 4 to Session 13, and again from December, 1885 (Session 27) to his death in 1892. He contributed several papers on chemical subjects, including the one on the Origin of Petroleum previously referred to, another on "Iron as a "colouring matter of Rocks" (Session 1886-7), and a third on "The colouring matter of the mineral 'Blue John'" (Session 1887-8). Mr. Tate's services were, however, more especially marked by his ready assistance and advice to other workers, and especially by the practical help and encouragement which he gave to the younger students of Geology and other natural sciences.

(APPENDIX.)

LIST OF PAPERS PRINTED IN THE PROCEEDINGS

(Arranged under the Names of the Authors.)

N.B.—The Proceedings are arranged in Volumes as follows:— Sessions 1-15 are not divided but are regarded as forming Vols. I and II; Vol. III contains Sessions 16-19; Vol. IV, Sessions 20-25; Vol. V, Sessions 26-29; Vol. VI, Sessions 30-33; Vol. VII, Sessions 34-37; Vol. VIII, Sessions 38-41; Vol. IX, Sessions 42-45; Vol. X, Sessions 46-50.

ARCHER, F., B.A.

Session

22. ('80-'81) Notes on the Worked Flints of the Raised Beaches of the N.E. Coast of Ireland.

BEASLEY, H C., F.G.S.

18. ('76-'77) Some Notes on Surface Sculpture.

19. ('77-'78) On the Microscopic Structure of the Carboniferous Limestone, with reference to its mode of deposition.

26. ('84-'85) A Quarry at Poulton, and the relation of the Glacial Markings there to others in the neighbourhood.

27. ('85-'86) On a Section of the Upper Keuper at Oxton.

28. ('86-'87) Some Instances of Horizontally Striated Slickensides.

29. ('87-'88) Some Irregularly Striated Joints in the Keuper Sandstone of Lingdale Quarry.

30. ('88-'89) *President's Address.* (Glacial and Post-Glacial Deposits and the Trias.)

31. ('89-'90) *President's Address.* (Life of the English Trias.)

What becomes of the water ejected from Volcanoes?

32. ('90-'91) The Base of the Keuper in the Northern Part of Wirral.

33. ('91-'92) (*with J. Lomas, F.G.S.*) Some East and West Faults at Caldy Grange.

The Bunter Conglomerate near Cheadle, Staffordshire.

37. ('95-'96) An Attempt to Classify the Footprints from the Trias of this district.

39. ('97-'98) Notes on Footprints from the Trias in some Provincial Museums.

A Section Recently Exposed on Prenton Hill.

42. ('00-'01) Some Recent Exposures of Keuper Marls, at Oxton, Birkenhead.

Notes on the Type Specimen of *Cheirotherium herculis*.

43. ('01-'02) On Two Footprints from the Lower Keuper, and their relation to the *Cheirotherium Storetonensis*.

44. ('02-'03) Some Lithographs of Footprints, etc., from Storeton, issued by the Liverpool Natural History Society about 1839.

47. ('05-'06) *President's Address.* (Some difficulties with regard to the formation of the Upper Keuper Marls.)

48. ('06-'07) *President's Address.* (The Storeton Find of 1906.)

49. ('07-'08) Some Markings, other than Footprints, in the Keuper Sandstones and Marls.

BONNEY, T. G., D.Sc., LL.D., F.R.S.

43. ('01-'02) Fragmental Rocks as Records of the Past.

BOSTOCK, R.

9. ('67-'68) The Probable Source of Holywell Spring.

10. ('68-'69) The New Red Sandstone as a Source of Water Supply.

11. ('69-'70) The Mersey and the Dee: their former Channels and Changes of Level.

12. ('70-'71) Alternations of Sea and Land Astronomically considered.

BRODRICK, H., M.A.

45. ('03-'04) British Caves. (Abstract.)

46. ('04-'05) Notes on a Recently Explored Fault-Fissure on Ingleborough.

50. ('08-'09) Notes on some recently discovered Footprints from the Inferior Oolite of Whitby, Yorkshire.

BROWN, J. CAMPBELL, D.Sc., F.C.S.

20. ('78-'79) Analysis of rocks from the 1,300 feet Deep Borehole at Bootle.

BROWN, W. D.

47. ('05-'06) On some Erratics of the Boulder Clay in the Neighbourhood of Burscough.

CALLAWAY, C., D.Sc., M.A., F.G.S.

37. ('95-'96) A Sketch of the Process of Metamorphism in the Malvern Crystallines.

38. ('96-'97) A Criticism on the chemical evidence for the existence of organisms in the oldest rocks.

42. ('00-'01) A Sketch of the Archæan Geology of Anglesey.

CLAY, W. G., M.A.

32. ('90-'91) Note on E. Dickson's Paper on Moraines and Glacial Streams.

COOKE, S. H. (Rev.), M.A.

3. ('61-'62) The Inferior Oolite. (Abstract.)
11. ('69-'70) On Deep Sea Dredgings in the Atlantic.

COPE, T. H., F.G.S.

38. ('96-'97) The Igneous Rocks of Aran Mowddwy.
40. ('98-'99) The Gabbro of Llyn Eigiau.
43. ('01-'02) Note on the Titaniferous Iron Sand of Porth-Dinlleyn.
45. ('03-'04) *President's Address.* (Types of Rock-Flow in the Ceiriog Valley, and their analogies with River-structure.)
46. ('04-'05) *President's Address.* (Some Geological Problems in South-West Lancashire.)
49. ('07-'08) Some Comparisons in the Weathering of Basalt.

CUMMING, L., M.A.

31. ('89-'90) Notes on Glacial Moraines.
33. ('91-'92) Note on E. Dickson's Paper on Mud Avalanches.
34. ('92-'93) Some observations on Mountain Debris.

DICKSON, E., F.G.S

28. ('86-'87) Notes on the Excavations for the Preston Docks.
29. ('87-'88) Geological Notes on the Preston Dock Works and Ribble Developement Scheme.
(*with P. Holland, F.I.C.*) Examination of Quartzite from Nills Hill, Pontesbury.
30. ('88-'89) (*with P. Holland*) Some Volcanic Rocks of the Isle of Man.
31. ('89-'90) (*with P. Holland*) Notes of Examination of water and sediment from the River Arveiron, near Argentière.
(*with P. Holland*) Note on the Examination of some Anglesey Rocks.
32. ('90-'91) Observations on Moraines and Glacial Streams in the Valley of the Rhone and near Grindelwald.
(*with P. Holland*) Examination of Glacial Waters and Deposits from the Rhone Valley and near Grindelwald, and of Glacial Waters from near Chamounix.
33. ('91-'92) Mud Avalanches.
Notes on the Devon Coast Section from Exmouth to Sidmouth.

34. ('92-'93) Note on Section at Skillaw Clough, near Parbold.

(*with P. Holland*) Remarks on the formation of Clay.

35. ('93-'94) *President's Address.* (The Ribble Estuary, with Notes on the Formation of Sand and the Disposal of Dissolved Matter in River Water.)

(*with P. Holland*) Notes on Shell Breccia Dredged off the Coast of the Isle of Man; and on the Source of the Carbonate of Lime of the Shells of Marine Organisms.

36. ('94-'95) *President's Address.* (Chemistry as an aid to Geology.)

Notes on the Geology of the Country between Preston and Blackburn.

Further Notes on the Section at Skillaw Clough, near Parbold (*with Note by B. Hobson, F.G.S.*).

37. ('95-'96) (*with P. Holland*) Notes on the Analyses of Triassic Rocks from the Neighbourhood of Liverpool.

38. ('96-'97) (*with P. Holland*) On some of the Geological features of the neighbourhood of the Varanger Fjord, Arctic Norway, with analyses of Terrace Deposits, Glacial Waters, &c.

40. ('98-'99) (*with P. Holland*) A Visit to Auvergne, with Analyses of Rocks.

41. ('99-'00) Notes on Glacial and Post-Glacial Deposits near Southport.

45. ('03-'04) Notes on some of the small Glaciers and Glacial Deposits near the Summit of the Furka Pass and a Comparison with similar Deposits in the English Lake District.

DAVIS, W. M. (Harvard University.)

47. ('05-'06) The Colorado Canyon and its Lessons.

DAVIES, D. C.

5. ('63-'64) The Bala Limestone and its Associated Beds in North Wales.

6. ('64-'65) List of Fossils described from the Bala Limestone, and its Associated Beds in North Wales.

DAVIES, T. W., A.M.I.C.E. (*with T. M. Reade, F.G.S.*)

36. ('94-'95) Description of the Strata exposed during the Construction of the Seacombe Branch of the Wirral Railway.

DAWKINS, BOYD, (Prof.) F.R.S.

21. ('79-'80) Memorandum on the Remains found in the Llandudno Cave. (see R. A. Eskrigge.)

DEACON, G. F., M. Inst. C.E.

30. ('88-'89) Note on the Glacial Geology of the Vyrnwy Valley

DUCKWORTH, H., F.G.S.

1. ('59-'60) *President's Address.* (Abstract.)

2. ('60-'61) The Fossils of Perim Island, in the Gulf of Cambay. (Abstract.)

President's Address. (Abstract.)

3. ('61-'62) Report of the Excursion made by the Society to Holywell.

Flint Implements from the Drift. (Account of a Visit to Amiens and Abbeville.)

4. ('62-'63) The Geology of the Egyptian Desert.

5. ('63-'64) The San Ciro Cave, near Palermo. (Abstract.)

6. ('64-'65) *President's Address.* (Notice only.)

Description of part of the Lower Jaw of a large Mammal, probably of Deinotherian Type, from Perim Island, Gulf of Cambay, India.

7. ('65-'66) *President's Address.*

DWERRYHOUSE, A. R., D.Sc., F.G.S.

34. ('92-'93) (*with J. Lomas*) The Glacial Deposits on the shore of the Mersey, between Hale Head and Decoy Marsh.

(*with J. Lomas*) On Some Faults Exposed in the Arno Quarry.

49. ('07-'08) *President's Address.* (The Planetesimal Hypothesis.)

50. ('08-'09) *President's Address.* (Carbonic Acid as a Geological Agent.)

EDWARDS, W., F.G.S.

43. ('01-'02) The Drift in the Neighbourhood of Crewe.

44. ('02-'03) The Surface Geology of Cheshire in its Relation to Agriculture.

46. ('04-'05) The Glacial Geology of Anglesey.

ESKRIGGE, R. A., F.G.S.

5. ('63-'64) Report of the Field Meeting at Castleton, Derbyshire.

6. ('64-'65) The Geology of the Country around Builth.

7. ('65-'66) Notes upon a Recent Earthquake near Ulverstone.

A New Locality for "Paradoxides Davidis" and Associated Fossils in North Wales.

9. ('67-'68) *President's Address.* (Stratigraphical History of Great Britain in Palæozoic Ages.)

Geological Observations on the Country around Maentwrog, N. Wales.

10. ('68-'69) *President's Address.* (Review of Recent Contributions to the Science of Geology.)

12. ('70-'71) The Theory of Colonies.

21. ('79-'80) Notes on Human Skeletons and Traces of Human Workmanship found in a Cave at Llandudno. (With Memorandum by Prof. Boyd Dawkins, F.R.S.)

FITZPATRICK, J. J.

28. ('86-'87) Some Uses of the Carboniferous Limestone.
30. ('88-'89) The Permian Conglomerate and other Palæozoic Rocks to the North of Morecambe Bay.
31. ('89-'90) Recent Discovery of a Bone Cave at Deep Dale, near Buxton.
32. ('90-'91) Report on the Field Meeting of the Society at a Section of the Middle Coal Measures between Garswood and St. Helens.
33. ('91-'92) Further Notes on the Deep Dale Bone Cave, near Buxton.
35. ('93-'94) The Permian Conglomerate of the Vale of Eden.
41. ('99-'00) Recent Discovery of Pebbles of Argentiferous Copper in Mexico.

GEORGE, I. E.

31. ('89-'90) Microscopical Examination of two Glacial Boulders.

GIVEN, J. C. M., M.D.

50. ('08-'09) Note on Some Glacial Striæ on Mossley Hill.

GREGSON, C. S.

3. ('61-'62) A Fossil Elytra from the Stonesfield Slate. (Abstract.)

GRENSTED, F. F. (Rev.), M.A.

29. ('87-'88) A Theory to Account for the Airless and Waterless Condition of the Moon
37. ('95-'96) A Contribution to the Dynamical Theory of the Craven Highlands.

GRIFFITHS, H. (Rev. Prof.)

4. ('62-'63) *President's Address.* (Notice only.)

HALL, C. R.

6. ('64-'65) Some Conjectural Hints towards determining the Ancient Coast-line of North Wales, between River Dee and Isle of Anglesea.

HALL, H. F., F.G.S.

6. ('64-'65) A Geological Ramble in Ireland.
7. ('65-'66) Notice of Submerged Forests at Rhos, near Colwyn.
8. ('66-'67) The Drift-Sections of the Holderness Coast, Yorkshire.

    Lacustrine Deposits of Holderness.
9. ('67-'68) The Geology of the District of Creuddyn, Llandudno. (On the Drift.)

HERDMAN, W. A. (Prof.), D.Sc., F.R.S.E.

26. ('84-'85) The Presence of Calcareous Spicula in the Tunicata.
The Conservative Action of Animals in relation to Dynamical Geology.

35. ('93-'94) Notes on the Sub-Marine Deposits of the Irish Sea.

39. ('97-'98) (*with J. Lomas, F.G.S.*) The Floor Deposits of the Irish Sea.

41. ('99-'00) *President's Address.* (The Geological Succession of Morphological Ideals.)

42. ('00-'01) *President's Address.* (The Geological Succession and the Origin of Man.)

HEWITT, W., B.Sc., Assoc. R.S.M.

27. ('85-'86) Notes on the Topography of Liverpool.

29. ('87-'88) Notes on Glacial Deposits and Markings in the South of the Isle of Man.

33. ('91-'92) *President's Address.* (The Earth in its Cosmical Relations.)

34. ('92-'93) *President's Address.* (The Physical Conditions of the Aralo-Caspian Region, as Bearing on the Conditions under which the Triassic Rocks were formed.)

39. ('97-'98) Sections Exposed on Site of New Technical Schools, Byrom Street.

HICKS, H., M.R.C.S.E., F.G.S.

5. ('63-'64) The Lower Lingula Flags of St. David's, Pembrokeshire.

10. ('68-'69) Notes on the Arenig Rocks in the Neighbourhood of St. David's.

HIGGINS, H. H., B.A. (Rev.)

1. ('59-'60) Arrangement of Fossils in the New Liverpool Museum. (Abstract.)

12. ('70-'71) On some Specimens supposed to be Fossils of a Plant named Pycnophyllum (Brogniart and Schimper); Flabellaria (Sternberg); Nœggerathia (Nonnul); in the Ravenhead Collection of Fossils, Free Public Museum, Liverpool.

13. ('71-'72) On some Fossil Ferns in the Ravenhead Collection, Free Public Museum, Liverpool.

HOBSON, B., M.Sc., F.G.S.

36. ('94-95) Notes on a Specimen of Permian Limestone from Skillaw Clough. (*See E. Dickson, F.G.S.*)

HOLLAND, P., F.I.C., F.C.S.

29. ('87-'88) (*with E. Dickson, F.G.S.*) Examination of Quartzite from Nills Hill, Pontesbury.

30. ('88-'89) (*with E. Dickson*) Some Volcanic Rocks of the Isle of Man.

31. ('89-'90) (*with E. Dickson*) Notes of Examination of Water and Sediment from the River Arveiron, near Argentière.

(*with E. Dickson*) Note on the Examination of some Anglesey rocks.

32. ('90-'91) (*with E. Dickson*) Examination of Glacial Waters and Deposits from the Rhone Valley and near Grindelwald, and of Glacial Waters from near Chamounix.

34. ('92-'93) (*with E. Dickson*) Remarks on the Formation of Clay.

35. ('93-'94) (*with E. Dickson*) Notes on Shell Breccia Dredged off the Coast of the Isle of Man; and on the Source of the Carbonate of Lime of the Shells of Marine Organisms.

37. ('95-'96) (*with E. Dickson*) Notes on the Analyses of Triassic Rocks from the neighbourhood of Liverpool.

38. ('96-'97) (*with E. Dickson*) On some of the Geological Features of the neighbourhood of the Varanger Fjord, Arctic Norway, with Analyses of Terrace Deposits, Glacial Waters, &c.

39. ('97-'98) (*with T. M. Reade, F.G.S.*) The Phyllades of the Ardennes Compared with the Slates of North Wales.

40. ('98-'99) (*with E. Dickson, F.G.S.*) A Visit to Auvergne, with Analyses of Rocks.

41. ('99-'00) (*with T. M. Reade, F.G.S.*) The Phyllades of the Ardennes Compared with the slates of North Wales. Part II.

42. ('00-'01) (*with T. M. Reade*) The Green Slates of the Lake District, with a Theory of Slate Structure and Slaty Cleavage.

45. ('03-'04) (*with T. M. Reade*) Sands and Sediments. Part I—Recent Fluviatile Deposits.

46. ('04-'05) (*with T. M. Reade*) Sands and Sediments. Part. II.

47. ('05-'06) (*with T. M. Reade*) Sands and Sediments. Part III.

48. ('06-'07) (*with T. M. Reade*) Analyses of Ludlow Rocks.

49. ('07-'08) (*with T. M. Reade*) Analyses of Longmyndian Rocks.

HOPKINSON, J., F.G.S., F.R.M.S.

14. ('72-'73) The Graptolites of the Arenig Rocks of St. David's, South Wales.

15. ('73-'74) On some Graptolites from the Upper Arenig Rock of Ramsey Island, St. David's.

HORTON, W. S., F.G.S.

2. ('60-'61) The Co-ordination of the Oolitic Strata of Wiltshire and Gloucestershire with that of Yorkshire. (Abstract.)

3. ('61-'62) The Stonesfield Slate and its Associated Strata. (Abstract.)

4. ('62-'63) The Geology of the Thames Valley.

5. ('63-'64) The Ironstone of the Middle Lias.

JACKSON, S. B.

4. ('62-'63) The Wigan Coal Field.

JEFFS, O. W.

27. ('85-'86) On the Occurrence of Copper in the Keuper of the Peckforton Hills.

28. ('86-'87) The Caldy-Grange Fault, West Kirby.

LOMAS, J., F.G.S., Assoc. R.C.S.

28. ('86-'87) On the Occurrence of Internal Calcareous Spicules in Polyzoa

A Section of Boulder-Clay near Hyde, Cheshire.

30. ('88-'89) Notes on some Basaltic Dykes occurring near Aros. Mull.

33. ('91-'92) Report on Glacial Deposits between Dingle Point, Liverpool, and Hale Head.

Some Pot-holes near Dingle Point.

Some Faults exposed in a Quarry near Thingwall Mill.

(*with H. C. Beasley, F.G.S.*) Some East and West Faults at Caldy Grange.

34. ('92-'93) (*with A. R. Dwerryhouse*) The Glacial Deposits on the Shore of the Mersey, between Hale Head and Decoy Marsh.

(*with A. R. Dwerryhouse*) On Some Faults Exposed in Arno Quarry

35. ('93-'94) On Artificial Perlitic Structure.

36. ('94-'95) Notes on Some Fossil Plants from Doulton's Delph, St. Helens.

Geology of the Faroe Islands.

A Theory to account for the Hexagonal Form of Basalt Columns and other Structures.

37. ('95-'96) Observations on Recent Glacial Striæ in Switzerland.

38. ('96-'97) The Earthquake of December 17, 1896.

39. ('97-'98) *President's Address.* (Do the Crystalline Gnessis represent portions of the original Earth's Crust?)

Microscopic Examination of Sandstones from Prenton and Bidston Hills.)

A Drift Section near Borough Road, Birkenhead.

(*with Prof. W. A. Herdman, F.R.S.*) The floor Deposits of the Irish Sea.

40. ('98-'99) *President's Address.* (Is there a Lithological Homotaxis?)

Notes on Swiss Glaciers.

On some Flint Implements found in the Glacial Deposits of Cheshire and North Wales.

42. ('00-'01) On the Occurrence of Estheria and Plant Remains in the Keuper Marls at Oxton and Birkenhead.

Some Pre-Glacial Land Surfaces at Prenton.

43. ('01-'02) On Some Antarctic Rock Specimens.

44. ('02-'03) Quartz Dykes near Foxdale, Isle of Man.

45. ('03-'04) The Coasts of Lancashire and Cheshire, their Forms and Origin.

47. ('05-'06) The Dwyka of South Africa.

48. ('06-'07) Desert Conditions and the Origin of the British Trias.

49. ('07-'08) The Mineralogical Constitution of the Storeton Sandstone.

On a Marine Peat from the Union Dock, Liverpool.

MACKINTOSH, D., F.G.S.

20. ('78-'79) On the Inter-Glacial Age of the Cave-Mammalia.

23. ('81-'82) Traces of an Inter-Glacial Surface at Crewe.

24. ('82-'83) *President's Address.* (On the Post-tertiary changes of level around the Coast of England and Wales.)

25. ('83-'84) *President's Address.* (The Time which has elapsed since the close of the Glacial Period.)

MARRAT, F. P.

13. ('71-'72) On the Fossil Ferns in the Ravenhead Collection. (With 12 lithographed plates.)

14. ('72-'73) Calamites and their Alliances.

20. ('78-'79) Recent and Fossil Nassa.

MARTIN, D. S., A.M.

17. ('75-'76) On the Rocks of New York Island and their Relation to the Geology of the Middle States. (Abstract.)

MAWBY. W.

35. ('93-'94) On the Occurrence of Phosphate of Iron coating Sand Grains at Tranmere.

35. ('93-'94) Notes on the Triassic Rocks of New Jersey, U.S.A.

McCLAY, J. L.

18. ('76-'77) Some Notes of the Geology of Londonderry, made during Holiday Rambles in that County.

MOORE, C. C., F.I.C.

39. ('97-'98) A Chemical Examination of Sandstones from Prenton Hill and Bidston Hill.

43. ('01-'02) *President's Address.* (The Study of the Volume Composition of Rocks and its Importance to the Geologist.)

44. ('02-'03) *President's Address.* (The Study of the Volume Composition of Rocks, Part II. The Examination of an Igneous Intrusion.)

MOORE, T. J., C.M.Z.S.L.

5. ('63-'64) The Fossils in the Collection of the Derby Museum of Liverpool. (Summary.)

6. ('64-'65) A Footprint, probably of the Iguanodon, in the Free Public Museum of Liverpool.

8. ('66-'67) Mammalian Remains from Cefn Cave.

9. ('67-'68) Some Fossil Mammalian Remains from North America, in the Free Public Museum of Liverpool.

13. ('71-'72) Notes on the Sivatherium of the Upper Miocene of the Sivalik Hills.

23. ('81-'82) Notes on the Mammalian Remains from Hightown. (See T. Mellard Reade.)

MORGAN, A.

11. ('69-'70. The Formation of Metalliferous Veins.

12. ('70-'71) Observations on Metalliferous Deposits.

17. ('75-'76) A Note on the Theory of Metalliferous Deposits in Veins.

17. ('75-'76) A Note on Itacolumyte or Flexible Sandstone.

18. ('76-'77) On Some Infusorial Earths, and the uses to which they are applied.

20. ('78-'79) A Review of Dr. F. V. Hayden's Geological and Topographical Atlas of Colorado, with a Sketch of the Geology of N. W. America.

MORTON, G. H., F.G.S., F.R.G.S.I.

1. ('59-'60) The Basement Bed of the Keuper Formation in Wirral and the S.W. of Lancashire. (Abstract.)

2. ('60-'61) The Geology of the neighbourhood of Shelve, in Shropshire. (Abstract. See also Session 1868-9.)

The Pleistocene Deposits of the District around Liverpool. (Abstract.)

3. ('61-'62) Report of the Excursion made by the Society to Coalbrookdale.

The Surface Markings near Liverpool, supposed to have been caused by Ice. (Abstract.)

The Thickness of the Bunter and Keuper Formations in the Country around Liverpool.

4. ('62-'63) The Ancient Glaciers of Snowdon. (Abstract.)

The Lingula Flags and the Strata beneath. (Abstract.)

Report of the Society's Field Meetings at Storeton and Leasowe.

Description of the Footprints of the Cheirotherium and Equisetum found at Storeton, Cheshire.

The Corals of the Silurian Sea.

5. ('63-'64) The Lias Formation as developed in Shropshire.

Report of the Field Meeting at Wigan.

A Section of the Strata at Thatto Heath, near Rainhill.

6.	('64-'65)	Report of the Society's Field Meeting at Llangollen Report of the Society's Field Meeting at Bidston Hill. The Records of Geological Time. (Abstract.) The Recent Shell-bed at Wallasey.
7.	('65-'66)	The Position of the Wells for the Supply of Water in the Neighbourhood of Liverpool. Granite and other Metamorphic Rocks. The Geology of the Country bordering the Mersey and Dee.
8.	('66-'67)	The Presence of Glacial Ice in the Valley of the Mersey during the Post-Pliocene Period.
9.	('67-'68)	Description of a Fault in a Granite Quarry at Aberdeen.
10.	('68-'69)	Palæontological Observations on the Carboniferous Limestone of Flintshire. The Geology and Mineral Veins of the Country around Shelve, Shropshire, with a Notice of the Breidden Hills.
11.	('69-'70)	*President's Address.* (The Progress of Geological Research in connection with the Geology of the Country around Liverpool).
12.	('70-'71)	*President's Address.* (The Progress of Geological Research in connection with the Geology of the Country around Liverpool).
13.	('71-'72)	Minerals that occur in the neighbourhood of Liverpool, with the Localities, &c. Shells Found in the Glacial Deposits around Liverpool, with the Localities, &c.
15.	('73-'74)	List of Works Relating to the Carboniferous Limestone and Millstone Grit of North Wales.
17.	('75-'76)	Notes on the Relation between the Mineral Flint and the County of Flint. Records of Glacial Striæ in Denbighshire, Flintshire, and Anglesea. The Carboniferous Limestone and Millstone Grit of North Wales—Llangollen.
18.	('76-'77)	The Glacial Striæ of the Country around Liverpool. On the Graptolites Found in the Lower Llandeilo Strata, near the Church, Shelve, Shropshire.
19.	('77-'78)	Section of Drift-beds observed in sinking for Water at Aughton, near Ormskirk.
22.	('80-'81)	On the Carboniferous Limestone of Gower, compared with that of North Wales. List of Papers on the Geology of the Country around Liverpool since 1870.
23.	('81-'82)	Notice of the recent Fall of an Aërolite, near Middlesbrough, Yorkshire. The Carboniferous Limestone and Cefn-y-Fedw Sandstone of Flintshire.

23, ('81-'82) The Base of the New Red Sandstone in the Country around Liverpool.

24. ('82-'83) The Carboniferous Limestone and Cefn-y-Fedw Sandstone of Flintshire, Part II: The Country to the North of Mold.

Notes on the Carboniferous Limestone of Belgium, made during a recent visit to that country.

Description of a Geological Map of the Storeton Quarries, Cheshire. (Abstract.)

25. ('83-'84) Section across the Trias recently exposed by a Railway excavation in Liverpool.

26. ('84-'85) The Microscopic Character of the Triassic Sandstones of the Country around Liverpool.

27. ('85-'86) The Carboniferous Limestone and Cefn-y-Fedw Sandstone of Flintshire

28. ('86-'87) *President's Address.* (Early Life on the Earth.)

Note on the Carboniferous Limestone Fishes of North Wales.

The Microscopic Characters of the Cefn-y-Fedw Sandstone of Denbighshire and Flintshire.

The Microscopic Characters of the Millstone Grit of S.W. Lancashire.

29. ('87-'88) *President's Address.* (Local Historical, Post-Glacial, and Pre-Glacial Geology.)

Stanlow, Ince, and Frodsham Marshes.

30. ('88-'89) Further Notes on the Stanlow, Ince, and Frodsham Marshes.

Some Faults Exposed in Shafts and Borings in the Neighbourhood of Liverpool.

32. ('90-'91) Faulted areas in the Country around Liverpool.

List of papers on Local Geology since 1881.

38. ('96-'97) The Carboniferous Limestone of the Vale of Clwyd.

39. ('97-'98) The Carboniferous Limestone of the Vale of Clwyd. Part II.

40. ('98-'99) Description of a Geological Map of Liverpool.

42. ('00-'01) The Carboniferous Limestone of Anglesey.

NIXON, E.

7. ('65-'66) The Coal Fields of Denbighshire and Flintshire.

PICTON, J. A., (Sir), F.S.A.

15. ('73-'74) Notes on the Phenomena of Glacial Action in Norway.

30. ('88-'89) Notes on the Local Historical Changes in the Surface of the Land in and about Liverpool.

30. ('88-'89) The Vyrnwy Valley, its Geological and Glacial History.

POTTER, C.

10. ('68-'69) Observations on the Cheshire Coast.

READE, T. MELLARD, C.E., F.G.S., F.R.I.B.A.

13.	('71-'72)	The Geology and Physics of the Post Glacial Period, as shewn in the Deposits and Organic Remains in Lancashire and Cheshire.
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		The Buried Valley of the Mersey.
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16.	('74-'75)	The Glacial and Post-Glacial Deposits of Garston and the surrounding District, with Remarks on the Structure of the Boulder Clay.
		Speculations on the Probable Distribution of Land and Sea during the Deposition of the Marine Boulder-Clays and Sands.
17.	('75-'76)	*President's Address.* (The Moon and the Earth.)
		The Lower Lias of Street, Somerset.
		The Formby and Leasowe Marine Beds, as shown in a Section near Freshfield.
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		Glacial Striations at Little Crosby.
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		Some Further Notes on the Submarine Forest at the Alt Mouth.
20.	('78-'79)	Notes on the Scenery and Geology of Ireland.
21.	('79-'80)	The Glacial Beds of the Clyde and Forth.
22.	('80-'81)	Notes on the Southern Drifts of England and Wales.
23.	('81-'82)	On a Section of the Formby and Leasowe Marine Beds, and Superior Peat Bed, disclosed by the Cuttings for the Outlet Sewer at Hightown. (with Note on Mammalian Remains by T. J. Moore.)
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25.	('83-'84)	Experiments on the Circulation of Water in Sandstone.
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		The Mersey Tunnel: Its Geological Aspects and Results.
		Borings on the Southport and Cheshire Lines Extension Railway.
		On a Section across the River Douglas at Hesketh Bank: A Post-Glacial Deposit in which were Human Bones.
27.	('85-'87)	*President's Address.* (The North Atlantic as a Geological Basin.)
		Notes on a bed of Fresh-water Shells and a Chipped Flint from the Alt Mouth.
		Boulders wedged in the Falls of the Cynfael.

27.	('85-'86)	On a Section of the Trias at Vyrnwy Street, Everton, displaying Evidence of Lateral Pressure.
29.	('87-'88)	Geological and Physical Notes on Rev. F. Grensted's Paper on "A Theory to account for the Airless and Waterless Condition of the Moon."
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		Notes on a Large Boulder found in Driving a Sewer Heading in Oxford Road, Manchester.
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		Note on a Boulder met with in Driving a Sewer Heading in Addison Street, Liverpool.
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32.	('90-'91)	The Trias of the Vale of Clwyd.
		A Section of the Trias and Boulder Clay in Chapel Street, Liverpool.
		Further Note on the Decomposed Boulder and Underlying Red Sandstone in the Chapel Street Section, Liverpool.
33.	('91-'92)	The Rounding of Sandstone Grains as bearing on the Divisions of the Bunter.
		The Trias of Cannock Chase.
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		Foraminiferal Boulder Clay, Riverside, Seacombe, Cheshire.

41. ('99-'00) (*with P. Holland, F.I.C.*) The Phyllades of the Ardennes Compared with the Slates of North Wales. Part II.

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43. ('01-'02) Glacial and Post-Glacial Features of the Lower Valley of the River Lune and its Estuary, with List of Foraminifera by Joseph Wright, F.G.S.

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(*with P. Holland, F.I.C.*) Sands and Sediments. Part I—Recent Fluviatile Deposits.

46. ('04-'05) Notes on some Specimens of Lancashire Boulder Clay.

Sands and Sediments. Part II.

47. ('05-'06) (*with Jos. Wright, F.G.S.*) The Pleistocene Clays and Sands of the Isle of Man.

(*with P. Holland, F.I.C.*) Sands and Sediments. Part III. (Final.)

48. ('06-'07) (*with P. Holland, F.I.C.*) Analyses of Ludlow Rocks.

49. ('07-'08) Post-Glacial Beds at Great Crosby as disclosed by the New Outfall Sewer.

(*with P. Holland, F.I.C.*) Analyses of Longmyndian Rocks.

RHODES, E., F.G.S.

41. ('99-'00) Notes on Crystals Found in Alkali Waste, Widnes, Lancashire.

RICKETTS, C.

7. ('65-'66) A Wooden Implement found in Bidston Moss.

8. ('66-'67) The Outlier of Carboniferous Limestone near Corwen, North Wales.

The Oscillations of Level on the Coast of Hampshire during the Eocene Period.

9. ('67-'68) The Succession of the Strata in the Church Stretton District.

Remarks on the Upper Silurian Formation.

10. ('68-'69) The Geology of the Neighbourhood of Ingleborough. Part, I Silurian; Part II, Carboniferous.

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The Sections of Strata Exposed on the Huyton and St. Helens Branch Railway.

12. ('70-'71) Remarks on the Lower Silurian Rocks in the Neighbourhood of Llanfyllin, and on the Contortions of the Strata.

13. ('71-'72) *President's Address.* (Valleys, Deltas, Bays and Estuaries.)
Remarks on the Volcanic Rocks near Edinburgh.
14. ('72-'73) *President's Address.* (Fissures, Faults, Contortions and Slaty Cleavage.)
15. ('73-'74) The Metamorphic Rocks of the Malvern Range and the Strata derived from them.
16. ('74-'75) The Cause of the Glacial Period with Reference to Great Britain.
17. ('75-'76) Remarks on the Country around the Wrekin.
18. ('76-'77) The Conditions existing during the Glacial Period; with an Account of Glacial Deposits between Tranmere and Oxton, Cheshire.
20. ('78-'79) On Some Remarkable Pebbles in the Boulder-Clay.
21. ('79-'80) On the Carboniferous Limestone near Skipton, and in North Derbyshire.
22. ('80-'81) On Split and other Boulders.
25. ('83-'84) On Indented Pebbles in the Bunter Sandstone, near Prescot.
27. ('85-'86) The Occurrence of Bitumen in Palæozoic Rocks of Shropshire.
Impressions of Footprints and Plants from the Trias at Oxton Heath.
28. ('86-'87) The Base of the Carboniferous Limestone.
31. ('89-'90) Remarks on the Contorted Schists of Anglesey.
32. ('90-'91) *President's Address* (Some Phenomena which occurred during the Glacial Epoch.)
34. ('92-'93) On Some Conditions Existing during Formation of the Older Carboniferous Rocks.

ROBERTS, ISAAC, C.E., F.G.S.

10. ('68-'69) The Wells and Water of Liverpool.
12. ('70-'71) Effect Produced by Red Sandstone upon Salt Water.
Sections of the Boulder-Clay at the Gas Works, Linacre, near Liverpool.
14. ('72-'73) Section of Strata above the Boulder-Clay at Whitechapel, Liverpool.
15. ('73-'74) *President's Address.* (Volcanoes and Volcanic Agency.)
16. ('74-'75) *President's Address.* (Glacial Deposits.)
22. ('80-'81) Notes on the Strata and Water Level at Maghull.

SEMMONS, W.

16. ('74-'75) The Metallic Ores of Cornwall. Group 1: Tin, Copper, Iron, and Lead.
18. ('76-'77) Copper Pitch-Blende and its Associations.
19. ('77-'78) Notes on Chrysocolla.
Notes on the Mineralogical Structure of some Cornish Granites.

20. ('78-'79) On Some Pseudomorphs of Chrysocolla after Atacamite.
21. ('79-'80) *President's Address.*
22. ('80-'81) *President's Address.* (Granites.)

SMITH, J.

41. ('99-'00) The Drift Beds and Boulders of the Louther and Neighbouring Hills and Valleys.

STRAHAN, A., M.A., F.G.S.

20. ('78-'79) On Some Glacial Striæ on the North Wales Coast.

TATE A. NORMAN, F.C.S., F.I.C.

4. ('62-'63) The Composition of Black Sandstone occurring in the Trias around Liverpool.
9. ('67 '68) The Relation of Chemistry to Geology.
10. ('68-'69) The Chemistry of the Primæval Earth.
27. ('85-'86) The Origin of Petroleum and other Natural Hydrocarbons.
28. ('86-'87) Iron as a Colouring Matter of Rocks.
29. ('87-'88) On the Colouring Matter of the Mineral "Blue John."

TIMMINS, A., C.E.

28. ('86-'87) On the Occurrence of Copper in the Bunter Conglomerate of Huntington, Staffordshire.
30. ('88-'89) Notes on a few Borings, and the Base of the New Red Sandstone in the Neighbourhood of Liverpool.

TRAVIS, C. B.

50. ('08-'09) On Some Ordovician Rhyolites and Tuffs of Nant Ffrancon.

WALKER, D., M.D., F.R.G.S.

2. ('60-'61) The Geology of the Arctic Regions, visited during a Voyage of the "Fox" in the years 1857-8. (Abstract.)

WARD. T.

23. ('81-'82) The Subsidences of Land in the Salt Districts of Cheshire, and their Connection with the Manufacture of Salt.

WATTS, W. W. (Prof.), M.A., M.Sc., F.R.S.

45. ('03-'04) The Buried Landscape of Charnwood Forest.

WHITAKER, W., B.A., F.G.S.

17. ('75-'76) List of Works on the Geology, Mineralogy, and Palæontology of Cheshire.

WORTHY, G. S.

2. ('60-'61) The Geology of Aust Cliff, Gloucestershire. (Abstract.)

WRIGHT, J., F.G.S. (*with T. M. Reade, F.G.S.*)

47. ('05-'06) The Pleistocene Clays and Sands of the Isle of Man.

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